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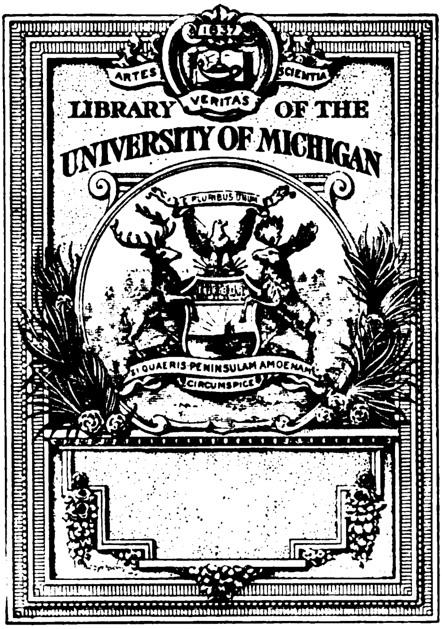
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OBSERVATIONS

ON

MAN

Richd McKenzie

J. S. Morris

HIS FRAME, HIS DUTY, AND HIS EXPECTATIONS.

10785

IN TWO PARTS.

PART THE FIRST:

CONTAINING

OBSERVATIONS ON THE

FRAME OF THE HUMAN BODY AND MIND,

AND ON THEIR

MUTUAL CONNECTIONS AND INFLUENCES.

BY DAVID HARTLEY, M. A.

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a.

Mr. Morris Pollok requests
Mr. Richd. Venables's acceptance
of this Work.

9th Decr. 1817

THE

PREFACE.

THE work here offered to the public conſiſts of papers written at different times, but taking their riſe from the following occaſion.

About eighteen years ago I was informed, that the Rev. Mr. GAY, then living, aſſerted the poſſibility of deducing all our intellectual pleaſures and pains from aſſociation. This put me upon conſidering the power of aſſociation. Mr. GAY publiſhed his ſentiments on this matter, about the ſame time, in a Diſſertation on the fundamental Principle of Virtue, prefixed to Mr. Archdeacon LAW's Tranſlation of Archbiſhop KING's Origin of Evil.

From inquiring into the power of aſſociation I was led to examine both its conſequences, in reſpect of morality and religion, and its phyſical cauſe. By degrees many diſquiſitions foreign to the doctrine of aſſociation, or at leaſt not immediately connected with it, intermixed themſelves. I have here put together all my ſeparate papers on theſe ſubjects, digeſting them in ſuch order as they ſeemed naturally to ſuggeſt; and adding ſuch things as were neceſſary to make the whole appear more complete and ſyſtematical.

I think, however, that I cannot be called a ſyſtem-maker, ſince I did not firſt form a ſyſtem, and then ſuit the facts to it, but was carried on by a train of thoughts from one thing to another, frequently without any expreſs deſign, or even any previous ſuſpicion of the conſequences that might ariſe. And this was moſt remarkably the caſe, in reſpect of the doctrine of *neceſſity*; for I was not at all aware, that it followed from that of aſſociation, for ſeveral years after I had begun my inquiries; nor did I admit it at laſt without the greateſt reluctance.

There are two things in theſe papers, which require a particular apology. Firſt, The imperfect ſtate in which they are preſented to the reader. Secondly, The great freedom which I have uſed in reſpect of all orders of men in the concluſion of the ſecond part.

As to the firſt; If the reader will be ſo favourable to me as to expect nothing more than hints and conjectures in difficult and obſcure matters, and a ſhort detail of the principal reaſons and evidences in thoſe that are clear, I hope he will not be much diſappointed. However, be this as it will, I have in one part or other of theſe papers alleged all that I know material, in ſupport of my ſyſtem; and therefore am now deſirous to recommend it to the conſideration of others.

I have tried to reconcile ſuch inconſiſtencies, real or apparent, and to cut off ſuch repetitions and redundancies, as have ariſen from my writing the ſeparate parts of this work at different times, and in different ſituations of mind. But I have ſtill need of great indulgence from the reader on theſe and other accounts.

As to the ſecond thing; I can truly ſay, that my free and unreſerved manner of ſpeaking has flowed from the ſincerity and earneſtneſs of my heart. But I will not undertake to juſtify all that I have ſaid. Some things may be too haſty and cenſorious; or, however, be unbecoming my place and ſtation. I heartily wiſh, that I could have obſerved the true medium. For, want of candour is not leſs an offence againſt the goſpel of Chriſt, than falſe ſhame, and want of courage in his cauſe.

Some perſons may perhaps think, that I ought not to have delivered my opinions ſo freely and openly, concerning the neceſſity of human actions, and the ultimate happineſs of all mankind; but have left the reader to deduce theſe conſequences, or not, as ſhould appear moſt reaſonable to him. But this would, in my opinion, have been a diſingenuous procedure. Beſides, theſe tenets appear to me not only innocent, but even highly conducive to the promotion of piety and virtue amongſt mankind. However, that no one may miſapprehend me to his own hurt, I will here make two remarks by way of anticipation.

Firſt, then, I no where deny practical free-will, or that voluntary power over our affections and actions, by which we deliberate, ſuſpend, and chooſe, and which makes an eſſential part of our ideas of virtue and vice, reward and puniſhment; but, on the contrary, eſtabliſh it (if ſo plain a thing will admit of being farther eſtabliſhed) by ſhewing in what manner it reſults from the frame of our natures.

Secondly, I do moſt firmly believe, upon the authority of the ſcriptures, that the future puniſhment of the wicked will be exceedingly great both in degree and duration, *i. e.* infinite and eternal, in that real practical ſenſe to which alone our conceptions extend. And were I able to urge any thing upon a profane careleſs world, which might convince them of the infinite hazard to which they expoſe themſelves, I would not fail to do it, as the reader may judge even from thoſe paſſages for which I have above apologized.

DECEMBER, 1748.

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OBSERVATIONS
ON
MAN, &c.

IN TWO PARTS.

PART I.

Containing OBSERVATIONS *on the* FRAME *of the* HUMAN BODY *and* MIND, *and on their* MUTUAL CONNECTIONS *and* INFLUENCES.

……

INTRODUCTION.

MAN conſiſts of two parts, body and mind.

The firſt is ſubjected to our ſenſes and inquiries, in the ſame manner as the other parts of the external material world.

The laſt is that ſubſtance, agent, principle, &c. to which we refer the ſenſations, ideas, pleaſures, pains, and voluntary motions.

Senſations are thoſe internal feelings of the mind, which ariſe from the impreſſions made by external objects upon the ſeveral parts of our bodies.

All our other internal feelings may be called *ideas*. Some of theſe appear to ſpring up in the mind of themſelves, ſome are ſuggeſted by words, others ariſe in other ways. Many writers comprehend *ſenſations* under *idea*; but I every where uſe theſe words in the ſenſes here aſcribed to them.

The ideas which reſemble ſenſations, are called *ideas of ſenſation*: all the reſt may therefore be called *intellectual ideas*.

It will appear in the courſe of theſe obſervations, that the *ideas of ſenſation* are the elements of which all the reſt are compounded. Hence *ideas of ſenſation* may be termed *ſimple*, *intellectual* ones *complex*.

The *pleaſures* and *pains* are comprehended under the ſenſations and ideas, as theſe are explained above. For all our pleaſures and pains are internal feelings, and, converſely, all our internal feelings ſeem to be attended with ſome degree either of *pleaſure* or *pain*. However, I ſhall, for the moſt part, give the names of *pleaſure* and *pain* only to ſuch degrees as are conſiderable; referring all low, evaneſcent ones to the head of *mere ſenſations* and *ideas*.

The pleaſures and pains may be ranged under ſeven general claſſes, viz.

1. Senſation;
2. Imagination;
3. Ambition;
4. Self-intereſt;
5. Sympathy;
6. Theopathy; and,
7. The moral ſenſe; according as they ariſe from,

1. The impreſſions made on the external ſenſes;
2. Natural or artificial beauty or deformity;
3. The opinions of others concerning us;
4. Our poſſeſſion or want of the means of happineſs, and ſecurity from, or ſubjection to, the hazards of miſery;

5. The pleaſures and pains of our fellow-creatures;

6. The affections excited in us by the contemplation of the Deity; or,

7. Moral beauty and deformity.

The human mind may alſo be conſidered as indued with the faculties of *memory*, *imagination* or *fancy*, *underſtanding*, *affection*, and *will.*

Memory is that faculty, by which traces of ſenſations and ideas recur, or are recalled, in the ſame order and proportion, accurately or nearly, as they were once actually preſented.

When ideas, and trains of ideas, occur, or are called up, in a vivid manner, and without regard to the order of former actual impreſſions and perceptions, this is ſaid to be done by the power of *imagination* or *fancy.*

The *underſtanding* is that faculty, by which we contemplate mere ſenſations and ideas, purſue truth, and aſſent to, or diſſent from, propoſitions.

The *affections* have the pleaſures and pains for their objects; as the *underſtanding* has the mere ſenſations and ideas. By the affections we are excited to purſue happineſs, and all its means, fly from miſery, and all its apparent cauſes.

The *will* is that ſtate of mind, which is immediately previous to, and cauſes, thoſe expreſs acts of memory, fancy, and bodily motion, which are termed *voluntary.*

The *motions* of the body are of two kinds, *automatic* and *voluntary.* The *automatic* motions are thoſe which ariſe from the mechaniſm of the body in an evident manner. They are called *automatic*, from their reſemblance to the motions of *automata*, or machines, whoſe principle of motion is within themſelves. Of this kind are the motion of the heart, and periſtaltic motion of the bowels. The *voluntary motions* are thoſe which ariſe from ideas and affections, and which therefore are referred to the mind; the immediately preceding ſtate of the mind, or of the ideas and affections, being termed *will*, as noted in the laſt article. Such are the actions of walking, handling, ſpeaking, &c. when attended to, and performed with an expreſs deſign.

This may ſerve as a ſhort account of the chief ſubjects conſidered in the firſt part of theſe *obſervations*. Theſe ſubjects are ſo much involved in each other, that it is difficult, or even impoſſible, to begin any where upon clear ground, or ſo as to proceed entirely from the *Data* to the *Quæſita*, from things known to ſuch as are unknown. I will endeavour it as much as I can, and for that purpoſe ſhall obſerve the following order.

Firſt, I ſhall lay down the general laws, according to which the ſenſations and motions are performed, and our ideas generated.

Secondly, I ſhall conſider each of the ſenſations and motions in particular, and inquire how far the phænomena of each illuſtrate, and are illuſtrated by, the foregoing general laws.

Thirdly, I ſhall proceed in like manner to the particular phænomena of ideas, or of underſtanding, affection, memory, and imagination; applying to them what has been before delivered.

Laſtly, I ſhall endeavour to give a particular hiſtory and analyſis of the ſix claſſes of intellectual pleaſures and pains, viz. thoſe of imagination, ambition, ſelf-intereſt, ſympathy, theopathy, and the moral ſenſe.

OF THE
DOCTRINES OF VIBRATIONS
AND
ASSOCIATION IN GENERAL.

CHAP. I.

Of the GENERAL LAWS *according to which the* SENSATIONS *and* MOTIONS *are performed, and our* IDEAS GENERATED.

MY chief deſign in the following chapter, is, briefly, to explain, eſtabliſh, and apply the doctrines of *vibrations* and *aſſociation*. The firſt of theſe doctrines is taken from the hints concerning the performance of ſenſation and motion, which Sir *Iſaac Newton* has given at the end of his *Principia*, and in the *queſtions* annexed to his *Optics*; the laſt, from what Mr. *Locke*, and other ingenious perſons ſince his time have delivered concerning the influence of *aſſociation* over our opinions and affections, and its uſe in explaining thoſe things in an accurate and preciſe way, which are commonly referred to the power of habit and cuſtom, in a general and indeterminate one.

The doctrine of *vibrations* may appear at firſt ſight to have no connection with that of *aſſociation*; however, if theſe doctrines be found in fact to contain the laws of the bodily and mental powers reſpectively, they muſt be related to each other, ſince the body and mind are. One may expect that *vibrations* ſhould infer *aſſociation* as their effect, and *aſſociation* point to *vibrations* as its cauſe. I will endeavour, in the preſent chapter, to trace out this mutual relation.

The proper method of philoſophizing ſeems to be, to diſcover and eſtabliſh the general laws of action, affecting the ſubject under conſideration, from certain ſelect, well-defined, and well-atteſted phænomena, and then to explain and predict the other phænomena by theſe laws. This is the method of analyſis and ſyntheſis recommended and followed by Sir *Iſaac Newton*.

I ſhall not be able to execute, with any accuracy, what the reader might expect of this kind, in reſpect of the doctrines of *vibrations* and *aſſociation*, and their general laws, on account of the great intricacy, extenſiveneſs, and novelty of the ſubject. However, I will attempt a ſketch in the beſt manner I can, for the ſervice of future inquirers.

SECT. I.

OF THE DOCTRINE OF VIBRATIONS, AND ITS USE FOR EXPLAINING THE SENSATIONS.

PROP. I.

The white medullary Subſtance of the Brain, ſpinal Marrow, and the Nerves proceeding from them, is the immediate Inſtrument of Senſation and Motion.

UNDER the word *brain*, in theſe *obſervations*, I comprehend all that lies within the cavity of the ſkull, *i. e.* the *cerebrum*, or *brain*, properly ſo called, the *cerebellum*, and the *medulla oblongata.*

This propoſition ſeems to be ſufficiently proved in the writings of phyſicians and anatomiſts; from the ſtructure and functions of the ſeveral organs of the human body; from experiments on living animals; from the ſymptoms of diſeaſes, and from diſſections of morbid bodies. Senſibility, and the power of motion, ſeem to be conveyed to all the parts, in their natural ſtate, from the brain and ſpinal marrow, along the nerves. Theſe ariſe from the medullary, not the cortical part, every where, and are themſelves of a white medullary ſubſtance. When the nerves of any part are cut, tied, or compreſſed in any conſiderable degree, the functions of that part are either entirely deſtroyed, or much impaired. When the ſpinal marrow is compreſſed by a diſlocation of the *vertebræ* of the back, all the parts, whoſe nerves ariſe below the place of diſlocation, become paralytic. When any conſiderable injury is done to the medullary ſubſtance of the brain, ſenſation, voluntary motion, memory, and intellect, are either entirely loſt, or much impaired; and if the injury be very great, this extends immediately to the vital motions alſo, viz. to thoſe of the heart, and organs of reſpiration, ſo as to occaſion death. But this does not hold equally in reſpect of the cortical ſubſtance of the brain; perhaps not at all, unleſs as far as injuries done to it extend themſelves to the medullary ſubſtance. In diſſections after apoplexies, palſies, epilepſies, and other diſtempers affecting the ſenſations and motions, it is uſual to find ſome great diſorder in the brain, from preternatural tumors, from blood, matter, or ſerum, lying upon the brain, or in its ventricles, &c. This may ſuffice as general evidence for the preſent. The particular reaſons of ſome of theſe phænomena, with more definitive evidences, will offer themſelves in the courſe of theſe *obſervations*.

PROP. II.

The white medullary Subſtance of the Brain is alſo the immediate Inſtrument, by which ideas are preſented to the Mind: or, in other Words, whatever Changes are made in this Subſtance, correſponding Changes are made in our Ideas; and vice verſâ.

THE evidence for this propoſition is alſo to be taken from the writings of phyſicians and anatomiſts; but eſpecially from thoſe parts of theſe writings, which treat of the faculties of memory, attention, imagination, &c. and of mental diſorders. It is ſufficiently manifeſt from hence, that the perfection of our mental faculties depends upon the perfection of this ſubſtance; that all injuries done to it, affect the trains of ideas proportionably; and that theſe cannot be reſtored to their natural courſe, till ſuch injuries be repaired. Poiſons, ſpirituous liquors, opiates, fevers, blows upon the head, &c. all plainly affect the mind, by firſt diſordering the medullary ſubſtance. And evacuations, reſt, medicines, time, &c. as plainly reſtore the mind to its former ſtate, by reverſing the foregoing ſteps. But there will be more and more definite evidence offered in the courſe of theſe *obſervations*.

PROP. III.

The Senſations remain in the Mind for a ſhort Time after the ſenſible Objects are removed.

THIS is very evident in the ſenſations impreſſed on the eye. Thus, to uſe Sir *Iſaac Newton*'s words, "If a burning coal be nimbly moved round in a "circle, with gyrations continually repeated, the "whole circle will appear like fire; the reaſon of "which is, that the ſenſation of the coal, in the "ſeveral places of that circle, *remains impreſſed on* "*the ſenſorium*, until the coal return again to the "ſame place. And ſo in a quick conſecution of "the colours" (viz. red, yellow, green, blue, and purple, mentioned in the experiment, whence this paſſage is taken) "the impreſſion of every colour "*remains on the ſenſorium*, until a revolutiou of all "the colours be completed, and that firſt colour "return again. The impreſſions therefore of all "the ſucceſſive colours, *are at once in the ſenſorium*— "and beget a ſenſation of white." *Opt*. B. I. p. 2. *Experiment* 10.

Thus alſo, when a perſon has had a candle, a window, or any other lucid or well-defined object, before his eyes, for a conſiderable time, he may perceive a very clear and preciſe image thereof to be left in the *ſenſorium*, fancy, or mind (for theſe I conſider as equivalent expreſſions in our entrance upon theſe diſquiſitions), for ſome time after he has cloſed his eyes. At leaſt this will happen frequently to perſons, who are attentive to theſe things, in a gentle way: for as this appearance eſcapes the notice of thoſe who are entirely inattentive, ſo too earneſt a deſire and attention prevents it, by introducing another ſtate of mind or fancy.

To theſe may be referred the appearance mentioned by Sir *Iſaac Newton*, *Opt*. *Qu*. 16. viz. "When "a man in the dark preſſes either corner of his "eye with his finger, and turns his eye away from "his finger, he will ſee a circle of colours like thoſe "in the feather of a peacock's tail. And this "appearance continues about a ſecond of time, "after the eye and finger have remained quiet." The ſenſation continues therefore in the mind about a ſecond of time after its cauſe ceaſes to act.

The ſame continuance of the ſenſations is alſo evident in the ear. For the ſounds which we hear, are reflected by the neighbouring bodies; and therefore conſiſt of a variety of ſounds, ſucceeding each other at different diſtances of time, according to the diſtances of the ſeveral reflecting bodies; which yet cauſes no confuſion, or apparent complexity of ſound, unleſs the diſtance of the reflecting bodies be very conſiderable, as in ſpacious buildings. Much leſs are we able to diſtinguiſh the ſucceſſive pulſes of the air, even in the graveſt ſounds.

As to the ſenſes of taſte and ſmell, there ſeems to be no clear direct evidence for the continuance of their ſenſations, after the proper objects are removed. But analogy would incline one to believe, that they muſt reſemble the ſenſes of ſight and hearing in this particular, though the continuance cannot be perceived diſtinctly, on account of the ſhortneſs of it, or other circumſtances. For the ſenſations muſt be ſuppoſed to bear ſuch an analogy to each other, and ſo to depend in common upon the brain, that all evidences for the continuance of ſenſations in any one ſenſe, will extend themſelves to the reſt. Thus all the ſenſes may be conſidered as ſo many kinds of feeling; the taſte is nearly allied to the feeling, the ſmell to the taſte, and the ſight and hearing to each other. All which analogies will offer themſelves to view, when we come to examine each of theſe ſenſes in particular.

In the ſenſe of feeling, the continuance of heat, after the heating body is removed, and that of the ſmart of a wound, after the inſtant of infliction, ſeem to be of the ſame kind with the appearances taken notice of in the eye and ear.

But the greateſt part of the ſenſations of this ſenſe reſemble thoſe of taſte and ſmell, and vaniſh to appearance as ſoon as the objects are removed.

PROP. IV.

External Objects impreſſed upon the Senſes occaſion, firſt in the Nerves on which they are impreſſed, and then in the Brain, Vibrations of the ſmall, and, as one may ſay, infiniteſimal, medullary Particles.

THESE vibrations are motions backwards and forwards of the ſmall particles; of the ſame kind with the oſcillations of pendulums, and the tremblings of the particles of ſounding bodies. They muſt be conceived to be exceedingly ſhort and ſmall, ſo as not to have the leaſt efficacy to diſturb or move the whole bodies of the nerves or brain. For that the nerves themſelves ſhould vibrate like muſical ſtrings, is highly abſurd; nor was it ever aſſerted by Sir *Iſaac Newton*, or any of thoſe who have embraced his notion of the performance of ſenſation and motion, by means of *vibrations*.

In like manner, we are to ſuppoſe the particles which vibrate, to be of the inferior orders, and not thoſe biggeſt particles, on which the operations in chemiſtry, and the colours of natural bodies, depend, according to the opinion of Sir *Iſaac Newton*. Hence, in the *propoſition*, I term the medullary particles, which vibrate, *infiniteſimal*.

Now that external objects impreſs vibratory motions upon the medullary ſubſtance of the nerves and brain (which is the immediate inſtrument of ſenſation, according to the *firſt propoſition)*, appears from the continuance of the ſenſations mentioned in the third; ſince no motion beſides a vibratory one, can reſide in any part for the leaſt moment of time. External objects, being corporeal, can act upon the nerves and brain, which are alſo corporeal, by nothing but impreſſing motion on them. A vibrating motion may continue for a ſhort time in the ſmall medullary particles of the nerves and brain, without diſturbing them, and after a ſhort time would ceaſe; and ſo would correſpond to the above-mentioned ſhort continuance of the ſenſations; and there ſeems to be no other ſpecies of motion that can correſpond thereto.

Cor. As this *propoſition* is deduced from the foregoing, ſo if it could be eſtabliſhed upon independent principles (of which I ſhall treat under the next), the foregoing might be deduced from it. And, on this ſuppoſition, there would be an argument for the continuance of the ſenſations, after the removal of their objects; which would extend to the ſenſes of feeling, taſte, and ſmell, in the ſame manner as to thoſe of ſight and hearing.

PROP.

PROP. V.

The Vibrations mentioned in the laſt Propoſition are excited, propagated, and kept up, partly by the Æther, i. e. *by a very ſubtle and elaſtic Fluid, and partly by the Uniformity, Continuity, Softneſs, and active Powers of the Medullary Subſtance of the Brain, ſpinal Marrow, and Nerves.*

THIS *propoſition* is chiefly an evidence and explanation of the foregoing; and accordingly might have been included in it. However, as it is of great importance in the preſent ſubject, I thought it beſt to give it a diſtinct place and conſideration.

Before I enter upon the proof of it, it will be proper to premiſe ſomething by way of explanation, concerning the æther, and the qualities of the medullary ſubſtance juſt mentioned.

Sir *Iſaac Newton* ſuppoſes, that a very ſubtle and elaſtic fluid, which he calls *æther*, for the ſake of treating upon it commodiouſly under an appropriated name, is diffuſed through the pores of groſs bodies, as well as through the open ſpaces, that are void of groſs matter. He ſuppoſes likewiſe, that it is rarer in the pores of bodies than in open ſpaces, and even rarer in ſmall pores and denſe bodies, than in large pores and rare bodies; and alſo that its denſity increaſes in receding from groſs matter, ſo, for inſtance, as to be greater at the $\frac{1}{100}$ of an inch from the ſurface of any body than at its ſurface; and ſo on. To the action of this æther he aſcribes the attractions of gravitation and cohæſion, the attractions and repulſions of electrical bodies, the mutual influences of bodies and light upon each other, the effects and communication of heat, and the performance of animal ſenſation and motion. My buſineſs in theſe *obſervations*, is only with the laſt; but the reader will do well to conſult what Sir *Iſaac Newton* has himſelf advanced concerning the exiſtence of this æther, and the properties and powers which he has aſcribed to it, in the laſt paragraph of his *Principia*, the *Queſtions* annexed to his *Optics*, and a *Letter* from him to Mr. *Boyle*, lately publiſhed in Mr. *Boyle*'s Life. As to myſelf, I am not ſatisfied, that I underſtand him perfectly on this ſubject. I will hint a few things partly from him, partly from my own reflections, concerning the exiſtence and properties of this æther.

Since a thermometer kept, *in vacuo*, varies with the heat and cold of the room, in which it is placed, as much as another ſurrounded by air; and ſince the ſmall parts of hot bodies probably vibrate to and fro, and by thus vibrating keep up the heat for a certain time; one may conjecture, that a ſubtle medium remains after the air is exhauſted, and that heat is communicated to the thermometer ſuſpended *in vacuo* by the vibrating motions of this medium. See *Opt*. *Qu*. 18.

The greater denſity of the æther at a diſtance from bodies than at their ſurface, may be conjectured from the various phænomena ſolved by this ſuppoſition; which phænomena may alſo be alleged as probable evidences of the exiſtence of the æther. See *Opt*. *Qu*. and the *Letter to Mr. Boyle*.

The great ſubtlety and elaſticity of the æther may be inferred from the motions of the planets, and quick propagation of light, if we firſt ſuppoſe its exiſtence, and concurrence in the propagation of light, and efficacy in cauſing gravity. And from its great elaſticity we may infer, that it is extremely ſuſceptible of vibrations and pulſes, in the ſame manner as common air. See *Opt*. *Quer*.

Since the groſs bodies that lie upon the ſurface of the earth emit air particles, conſtituting a thin, elaſtic fluid, of great efficacy in performing the ordinary operations of nature, it ſeems not unnatural to expect, that the ſmall particles of bodies ſhould emit a proportionably attenuated air, *i. e.* an æther, which may likewiſe have a great ſhare in the ſubtle actions of the ſmall particles of bodies over each other. The emiſſion of odoriferous particles, light, magnetical and electrical effluvia, may alſo be ſome preſumption in favour of the exiſtence of the æther. Moreover, it is reaſonable to expect, that it ſhould have a repulſive force in reſpect of the bodies which emit it; and for the ſame reaſons, its particles may repel each other. It may therefore be elaſtic, compreſſible, and apt to receive vibrations from the laſt cauſe; and, from the firſt, may be rarer within the pores of bodies than in large open ſpaces, and grow denſer as the diſtance from groſs matter increaſes. Our air is indeed denſer near the earth than in the higher regions; but this is owing to its gravity, prevailing againſt its expanſive force. If we ſuppoſe the gravity of the æther to be very ſmall, and its elaſticity or expanſive and repulſive force very great, both which muſt be ſuppoſed, if we admit it at all in the manner propoſed by Sir *Iſaac Newton*, its denſity may increaſe in receding from groſs matter, and be much leſs in the pores of bodies, than in open ſpaces void of groſs matter. Thus we may ſuppoſe even the air, which remains in the large pores of ſuch bodies as repel its particles, to be rarer than the common external air.

Laſtly, Let us ſuppoſe the exiſtence of the æther, with theſe its properties, to be deſtitute of all direct evidence, ſtill, if it ſerves to explain and account for a great variety of phænomena, it will have an indirect evidence in its favour by this means. Thus we admit the key of a cypher to be a true one, when it explains the cypher completely; and the decypherer judges himſelf to approach to the true key, in proportion

portion as he advances in the explanation of the cypher; and this without any direct evidence at all. And as the falſe and imperfect keys, which turn up to the decypherer in his reſearches prepare the way for the diſcovery of the true and complete one, ſo any hypotheſis that has ſo much plauſibility, as to explain a conſiderable number of facts, helps us to digeſt theſe facts in proper order, to bring new ones to light, and to make *Experimenta Crucis* for the ſake of future inquirers. The rule of falſe affords an obvious and ſtrong inſtance of the poſſibility of being led, with preciſion and certainty to a true concluſion from a falſe poſition; and it is of the very eſſence of algebra to proceed in the way of ſuppoſition.

We come next to conſider the uniformity and continuity of the white medullary ſubſtance of the brain, ſpinal marrow, and nerves. Now theſe are evident to the eye, as far as that can be a judge of them. The white medullary ſubſtance appears to be every where uniform and ſimilar to itſelf throughout the whole brain, ſpinal marrow, and nerves; and though the cortical ſubſtance be mixed with the medullary in the brain, and ſpinal marrow, and perhaps in the ganglions and plexuſes, yet it does not appear, that the communication of any one part of the medullary ſubſtance with every other, is cut off any where by the intervention of the cortical. There is no part of the medullary ſubſtance ſeparated from the reſt, but all make one continuous white body; ſo that if we ſuppoſe vibrations apt to run freely along this body from its uniformity, they muſt pervade the whole, in whatever part they are firſt excited, from its continu[illegible].

The exceſſive minuteneſs of the veſſels of which the medullary ſubſtance conſiſts, may alſo be conceived as inferring its uniformity and continuity. Theſe veſſels are, by all anatomiſts and phyſiologiſts, gifts, ſuppoſed to ariſe from thoſe of the cortical ſubſtance, this being agreeable to the analogy of the other parts of the body. And it follows from the ſame analogy, that they muſt be ſmaller than thoſe veſſels from which they ariſe. But the finer orders of the veſſels of the cortical ſubſtance are far too minute to admit of the moſt ſubtle injections, the beſt injectors having never penetrated farther than the groſſer orders of veſſels in the cortical ſubſtance. We may therefore well ſuppoſe, that the medullary ſubſtance conſiſts of a texture of veſſels ſo ſmall and regular, as that it may have no vacuity or interval in it, ſufficient to interrupt or diſturb the vibrations of the æther, and concomitant ones of the ſmall medullary particles, propagated through this ſubſtance in the manner to be deſcribed below.

The ſoftneſs of the medullary ſubſtance is, in like manner, evident to the ſenſes, and the natural conſequence of the extreme ſmallneſs of the compounding veſſels, and fluids circulating through them.

If we admit the foregoing account of the uniform continuous texture of the medullary ſubſtance, it will follow, that the nerves are rather ſolid capillaments, according to Sir *Iſaac Newton*, than ſmall *tubuli*, according to *Boerhaave*. And the ſame concluſion ariſes from admitting the doctrine of *vibrations*. The *vibrations* hereafter to be deſcribed may more eaſily be conceived to be propagated along ſolid capillaments, ſo uniform in their texture as to be pellucid when ſingly taken, than along hollow *tubuli*. For the ſame reaſons, the doctrine of *vibrations* will ſcarce permit us to ſuppoſe the brain to be a gland properly ſo called; ſince the difformity of texture required in a gland, appears inconſiſtent with the free propagation of vibrations. Neither can we conclude the brain to be a gland, from the great quantity of blood ſent to it by the heart. It is probable indeed, that this is required on account of the important functions of accretion, nutrition, ſenſation, and motion, which are plainly performed by the brain. But then theſe functions admit of as eaſy an explanation on the hypotheſis here propoſed, as on that of a glandular ſecretion, called nervous fluid, animal ſpirits, &c. In the mean time, I cannot but acknowledge many, or even moſt things, in the *Boerhaavian* doctrine concerning the ſtructure and functions of the brain, to be beautiful, juſt, and uſeful. And it may even be, that the doctrine of a glandular ſecretion, properly qualified, is not inconſiſtent with that of vibrations.

Sir *Iſaac Newton* ſuppoſes the nerves, when ſingly taken, to be pellucid, becauſe otherwiſe they could not be ſufficiently uniform for the purpoſe of tranſmitting vibrations freely to and from the brain; the opacity of any body being, according to him, an argument, that its pores are ſo large and irregular, as to diſturb and interrupt the vibrations of the æther. For the ſame reaſons, we muſt ſuppoſe the fibrils of the medullary ſubſtance of the brain to be pellucid, when ſingly taken. And this conſideration may incline one to conjecture, that, in palſies, the infiniteſimal veſſels of the fibrils of the brain, and capillaments of the nerves, are ſo obſtructed, as to render theſe fibrils and capillaments white and opake, in the ſame manner as the hairs in old age, or the *Cornea* in an *Albugo*.

Since the *Pia Mater*, with its blood veſſels, enters the interſtices of the ſeveral folds of the brain, one may ſuſpect, that it penetrates not only the cortical ſubſtance, but alſo the medullary, along with the ſeveral deſcending orders of veſſels, and conſequently that it divides and ſubdivides the medullary ſubſtance into various greater and leſſer regions. One may affirm at leaſt, that ſuch a diſtribution of the *Pia Mater* would be greatly analogous to that of the cellular membrane, through the ſyſtem of muſcles, their ſeparate portions, fibres, and fibrils. But then we may reaſonably ſuppoſe the *Pia Mater* to be ſo attenuated in theſe its proceſſes, as that the medullary ſubſtance may ſtill remain ſufficiently uniform for the free propagation of vibrations. Or, if there be ſome little impediment and confinement in certain regions, on account of ſome exceedingly ſmall diſcontinuity, ariſing from this intervention of the *Pia Mater* between certain regions, it may, as it ſeems to me, ſuit this theory rather better than an abſolute and perfect continuity, as before ſuppoſed. It is reaſonable alſo to think, that the nerves of different parts have innumerable communications with each other in the brain, in the ganglions (which are, as it were, little brains, according to the opinion of *Winſlow)*, and even in the plexuſes; and that many phænomena, particularly thoſe of the ſympathetic kind, are deducible from theſe communications. But as it ſeems impoſſible to trace out theſe communications anatomically, on account of the great ſoftneſs of the brain, we muſt content ourſelves with ſuch conjectures as the phænomena ſhall ſuggeſt, trying them by one another, and admitting for the preſent thoſe which appear moſt conſiſtent upon the whole, till farther light appears. The ſame, or even a greater, obſcurity attends all inquiries into the uſes of the particular ſhape and protuberances of the medullary ſubſtance of the brain.

We come, in the laſt place, to conſider what active properties may belong to the ſmall particles of the medullary ſubſtance, *i. e.* to the ſmall particles which compoſe either the ultimate veſſels of this ſubſtance, or the fluid which circulates in theſe ultimate veſſels. The common doctrine concerning the powers of the nervous ſyſtem ſuppoſes the fluid ſecreted by, and circulating through, the medullary ſubſtance, to be of a very active nature; and this may be, though the taſte of the medullary ſubſtance in brute animals diſcovers no ſuch activity. For the power of impreſſing taſtes, ſeems to reſide in particles much larger than thoſe which we are here conſidering. And it is ſufficiently obvious, that many poiſons, mineral, vegetable, and animal, have the moſt active properties concealed under inſipid, or at leaſt moderate ſavours. Now that ſome powers of attraction or repulſion, or rather of both at different diſtances, reſide in the ſmall particles of the medullary ſubſtance, can ſcarce be doubted after ſo many inſtances and evidences, as Sir *Iſaac Newton* has produced, of attractive and repulſive powers in the ſmall particles of various bodies, *Optics*, *Query* 31. meaning, as he does, by attraction and repulſion, a mere mathematical tendency to approach and recede, be the cauſe what it will, impulſe, preſſure, an unknown one, or no phyſical cauſe at all, but the immediate agency of the Deity. The ſmallneſs alſo of the particles of the medullary ſubſtance may not improbably increaſe their activity, in reſpect of their bulk, agreeably to Sir *Iſaac Newton*'s conjecture concerning the particles of the æther. Which may be farther inferred from the nature of theſe attractions and repulſions; for ſince they ſeem to be as ſome reciprocal power of the diſtance, we may judge, that only the neareſt parts of large particles will be eminently active, and that the more remote ones will be an impediment to their actions; whence ſmall particles, having nearly as great active powers, and much leſs matter to be moved, will, upon the whole, be more active in proportion to their bulk, than large ones. If we farther ſuppoſe the particles of the fluids, which circulate through the ultimate veſſels of the medullary ſubſtance, to be ſmaller than the particles which compoſe theſe veſſels, then will they alſo be more active. And thus we ſeem to approach to all that is probable in the received doctrines concerning the nervous fluid, and the animal ſpirits, ſuppoſed to be either the ſame or different things; and all the arguments which *Boerhaave*

haave has brought for his hypotheſis, of a glandular ſecretion of a very ſubtle active fluid in the brain, may be accommodated to the *Newtonian* hypotheſis of vibrations.

Having thus endeavoured to ſettle our notions concerning the æther, and eſtabliſh our evidences for its exiſtence and properties, and for the uniformity, continuity, ſoftneſs, and active powers of the medullary ſubſtance, we come, in the next place, to inquire in what manner theſe may ſerve to explain or evince the vibrations of the medullary particles, aſſerted in the foregoing *propoſition.*

Firſt then, We are to conceive, that when external objects are impreſſed on the ſenſory nerves, they excite vibrations in the æther reſiding in the pores of theſe nerves, by means of the mutual actions interceding between the objects, nerves, and æther. For there ſeem to be mutual actions of all the varieties between theſe three, in all the ſenſes, though of a different nature in different ſenſes. Thus it ſeems, that light affects both the optic nerve and the æther; and alſo, that the affections of the æther are communicated to the optic nerve, and *vice verſâ.* And the ſame may be obſerved of frictions of the ſkin, taſtes, ſmells, and ſounds. The impulſe, attraction, or whatever elſe be the action of the object, affects both the nerves and the æther; theſe affect each other, and even the object or impreſſion itſelf, in moſt or all caſes, ſo as to alter or modify it. And the reſult of theſe actions, upon the whole, may be ſuppoſed ſuch a compreſſion or increaſe of denſity in the æther, as muſt agitate its particles with vibrations analogous to thoſe which are excited in the air by the diſcharge of guns, by thunder-claps, or by any other method of cauſing a ſudden and violent compreſſion in it.

Secondly, We are to conceive, that the vibrations thus excited in the æther will agitate the ſmall particles of the medullary ſubſtance of the ſenſory nerves with ſynchronous vibrations, in the ſame manner as the vibrations of the air in ſounds agitate many regular bodies with correſponding vibrations or tremblings. And here the uniformity, ſoftneſs, and active powers of the medullary ſubſtance, muſt be conſidered as previous requiſites and aſſiſtances. A want of uniformity in the medullary ſubſtance, would argue a like want of uniformity in the æther contained within it. The hardneſs of it, if it extended to the particles, would cauſe an ineptitude to vibratory motions in the particles of theſe particles, *i. e.* in the infiniteſimal particles conſidered in this and the foregoing *propoſition.* And a want of active powers in theſe particles would ſuffer the excited motions to die away prematurely.

One may conjecture, indeed, that the rays of light excite vibrations in the ſmall particles of the optic nerve, by a direct and immediate action. For it ſeems probable, from the alternate fits of eaſy tranſmiſſion and reflection, that the rays of light are themſelves agitated by very ſubtle vibrations, and conſequently that they muſt communicate theſe directly and immediately to the particles of the optic nerves. And it may be alſo, that ſapid and odoriferous particles are agitated with ſpecific vibrations, and that they communicate theſe directly and immediately to the ſmall particles of the guſtatory and olfactory nerves reſpectively, as well as to the interjacent æther. Upon this ſuppoſition, the vibrations of the æther muſt be conceived as regulating and ſupporting the vibrations of the particles, not as exciting them originally.

Thirdly, The vibrations thus excited in the æther, and particles of the ſenſory nerves, will be propagated along the courſe of theſe nerves up to the brain. For the æther reſiding in the medullary ſubſtance, being of an uniform denſity on account of the ſmallneſs of the pores of the medullary ſubſtance, and uniformity of its texture, before taken notice of, will ſuffer the excited vibrations to run freely through it. And the ſame uniformity, together with the continuity, ſoftneſs, and active powers of the medullary ſubſtance, will farther contribute to the free propagation of the vibrations; ſince, on theſe accounts, it follows, that the particles, which were laſt agitated, may eaſily communicate their agitations or vibrations to the ſimilarly poſited and equally contiguous ones, without interruption, and almoſt without any diminution of force. This free propagation of vibrations along the courſe of the nerves may be illuſtrated and confirmed by the like free propagation of ſounds along the ſurface of water, which has ſometimes been obſerved in ſtill, calm nights.

Fourthly, The vibrations here deſcribed are confined to the medullary ſubſtance, or at leaſt are only propagated feebly and imperfectly into the neighbouring parts, on account of the heterogeneity and greater hardneſs of the neighbouring parts. The firſt will make the æther of different denſities, and, in ſome caſes, there may be almoſt an interruption or diſcontinuity of it; and the laſt will indiſpoſe the particles to receive and communicate vibrations; and we may ſuppoſe from both together, agreeably to what has been already remarked, that only ſmall vibrations, and ſuch irregular ones as oppoſe each other, will juſt begin to take place in the immediately contiguous parts, and there ceaſe without proceeding farther. It is ſomewhat analogous to this in ſounds, that they are much ſooner loſt in paſſing over rough ſurfaces than ſmooth ones; and particularly, that they receive a much greater diminution from the irregular ſurface of the earth, than from that of ſtill water. However, a particular exception is here to be made in reſpect of the fibres of the muſcles and membranes, into which the vibrations of the æther and medullary particles ſeem to be propagated with great freedom and ſtrength, as will be ſeen hereafter. Which may perhaps be ſome argument, that muſcular fibres are, according to *Boerhaave*'s opinion, mere productions of the ultimate nerves.

Fifthly, As ſoon as the vibrations enter the brain, they begin to be propagated freely every way over the whole medullary ſubſtance; being diminiſhed in ſtrength, in proportion to the quantity of matter agitated, juſt as in ſounds, *i. e.* as it were in a reciprocal duplicate *ratio* of the diſtance from the place where the ſenſory nerve affected by the vibrations enters the brain. Or, if we ſuppoſe the *Pia Mater* to make ſome ſmall diſcontinuity in the medullary ſubſtance by its proceſſes, as has been hinted above, then we muſt alſo ſuppoſe, that the vibrations, which aſcend along any ſenſory nerve, affect the region of the brain which correſponds to this ſenſory nerve more, and the other regions leſs, than according to this proportion.

Sixthly, Since the vibrations, or reciprocal motions, of the ſmall particles of each nerve are made in the ſame line of direction with the nerve, they muſt enter the brain in that direction, and may preſerve ſome ſmall regard to this direction at conſiderable diſtances within the brain; eſpecially if this be favoured by the ſtructure of the nervous fibrils in the brain. Hence the ſame internal parts of the brain may be made to vibrate in different directions, according to the different directions of the nerves by which the vibrations enter.

And thus it appears, that, admitting the exiſtence and ſubtlety of the æther, and the qualities of the medullary ſubſtance here alleged, a probable account may be given, how the vibrations, aſſerted in the laſt propoſition, may be excited in the ſenſory nerves, and propagated thence over the whole medullary ſubſtance,

ſtance, and over that alone. And the ſuitableneſs of this propoſition to the laſt, and of both to a variety of phænomena, which will be ſeen in the courſe of theſe obſervations, may be conſidered as ſome evidence for both.

Let it be remarked alſo, that, if the performance of ſenſation by vibratory motions of the medullary particles be admitted, the exiſtence of a ſubtle elaſtic fluid muſt be admitted in conſequence thereof, as the only means that can be conceived for their riſe and free propagation, ſo as to anſwer to the phænomena of ſenſe, motion, and ideas; and reciprocally, if the exiſtence of ſo ſubtle and elaſtic a fluid, as the æther deſcribed by Sir *Iſaac Newton*, can be eſtabliſhed upon independent principles, it may reaſonably be ſuppoſed to penetrate the pores of the medullary ſubſtance, how ſmall ſoever they be, in the ſame manner as air penetrates groſſer cavities and pores, and, like air, both be itſelf agitated by vibrations from a variety of cauſes, and alſo communicate theſe to the medullary particles. We may therefore either deduce the doctrine of vibrations here propoſed from the conſideration of the æther, or the exiſtence of the æther from the doctrine of vibrations, according as either of theſe can be firſt eſtabliſhed.

There is alſo ſome light and evidence to be caſt upon one or both of theſe propoſitions, from ſeveral natural phænomena; as I will endeavour to ſhew in the following remarks.

1. Heat in natural bodies is probably attended by vibrations of the ſmall parts. This may be inferred from the duration and gradual declenſion of heat, and from the groſs general proportion which is obſerved between this duration and the denſity of the heated body. For a vibratory motion would ſubſiſt for ſome time, decline gradually, and be kept up longer, *cæteris paribus*, where the number of vibrating particles were many, than where few. The

ſame hypotheſis is well ſuited to the rarefaction, fluidity, diſſolution, and other changes of texture which heat produces in bodies, according to their various natures. And if we farther conſider, that all bodies, contiguous to each other, come, after a ſhort time, to the ſame degree of heat, viz. that of the circumambient air; thoſe which are hotter loſing ſomething, and thoſe which are colder gaining; and yet that the air is not neceſſary for the conveyance of heat, as appears from Sir *Iſaac Newton*'s experiment of the two thermometers above-mentioned; it will appear highly probable, both that heat in bodies is attended by vibratory motions of the ſmall parts, and alſo that theſe are communicated to contiguous bodies by vibrations of a ſubtle fluid, by an argument ſomething different from that urged above, in ſpeaking of the two thermometers; at leaſt the conſideration of the equality of temperature, to which all contiguous bodies are known, by common obſervations, to arrive, will caſt ſome light upon that argument. And, upon the whole, it will follow, that heat in us is cauſed, or attended, by ſubtle vibrations of the medullary ſubſtance, which is the immediate inſtrument of all the ſenſations; and that a ſubtle fluid is concerned in the production of this effect. And what is thus proved of heat, may be inferred to hold in reſpect of all the other ſenſations, from the argument of analogy.

2. Light is ſo nearly related to heat, that we muſt ſuppoſe the argument of analogy to be particularly ſtrong in reſpect of it: but, beſides this, we have an independent argument for the exiſtence of vibrations here, alſo for their communication by a ſubtle fluid, if we admit Sir *Iſaac Newton*'s hypotheſis concerning the cauſe of the alternate fits of eaſy reflection and tranſmiſſion, as I have above remarked.

3. As ſounds are cauſed by pulſes or vibrations excited in the air by the tremors of the parts of

ſounding bodies, they muſt raiſe vibrations in the *membrana tympani*; and the ſmall bones of the ear ſeem peculiarly adapted, by their ſituation and muſcles, to communicate theſe vibrations to the cavities of the *veſtibulum*, ſemicircular canals, and *cochlea*, in which the auditory nerve is expanded; *i. e.* to the nerve itſelf. Now though theſe are groſs vibrations, in reſpect of thoſe which we muſt ſuppoſe to take place in the æther itſelf, yet they prepare the way for the ſuppoſition of the more ſubtle vibrations of the æther, and may be the inſtrument of theſe, in the ſame manner as very groſs reciprocal motions of bodies in the air are obſerved to produce, by percuſſion, thoſe quicker vibrations in which ſound conſiſts.

4. We are, in ſome meaſure, prepared alſo for admitting the doctrine of vibrations in the animal functions, from that diſpoſition to yield a ſound upon percuſſion, which appears in ſome degree in almoſt all bodies; ſince this ſhews, that the diſpoſition to vibrate is general, or even univerſal, in the bigger orders of particles; and therefore makes it more eaſy to conceive, that there may be a like diſpoſition in the leſſer orders, *i. e.* in the infiniteſimal medullary particles, conſidered in this and the foregoing *propoſition*.

5. The mutual attractions and repulſions which ſeem to intercede between all ſmall particles, concur to the ſame purpoſe. For when the attractions and repulſions are changed, by changing the diſtances of the particles, theſe muſt oſcillate to and fro for ſome time, before they can gain their former equilibrium.

6. Elaſticity ſeems to reſult from mutual attractions and repulſions of ſome kind, and is evidently the cauſe of vibrations in muſical ſtrings, and many other bodies. It ſeems alſo, that there is ſcarce any body entirely devoid of elaſticity. And thus elaſti-

city is connected with the doctrine of vibrations in different ways.

7. The effluvia of electric bodies ſeem to have vibrating motions. For they are excited by friction, patting, and heat; and excite light, ſound, and a pricking ſenſation. They have alſo a repulſive power in reſpect of each other, as the particles of air have; and therefore muſt, like them, be eaſily ſuſceptible of vibrations. Their motions along hempen ſtrings reſemble the motions along the nerves in ſenſation and muſcular contraction; and their attractive powers, at the end of ſuch ſtrings, reſemble the powers of the ſenſations over the muſcles for contracting them. So that electricity is alſo connected in various ways with the doctrine of vibrations.

Laſtly, To ſum up in one what has been remarked in the laſt five paragraphs: as the attractions of gravitation, electricity, magnetiſm, and coheſion, with the repulſions which attend upon the three laſt, intimate to us the general tenor of nature in this reſpect; viz. that many of its phænomena are carried on by attractions and repulſions; and that theſe may be expected to take place in the ſmall deſcending orders of particles, as well as in groſs bodies, and in the biggeſt component particles; ſo the pulſes of the air, the tremors of ſounding bodies, the propagation of ſounds both through the air, and along contiguous ſolid bodies, the oſcillations of elaſtic bodies, and the phænomena of electricity, may, in like manner, ſerve as a clue and guide to the invention, and afford a preſumption, that other reciprocal motions or vibrations have a great ſhare in the production of natural phænomena.

Nor is it an objection to this, but rather a confirmation of it, that theſe principles of attraction and repulſion of the ſeveral kinds, and of vibrations, are dependent upon, and involved within each other, ſince this alſo is agreeable to the tenor of nature, as it is obſerved in the body, in the mind, in ſcience in general, and in the ſeveral branches of each ſcience in particular, Each part, faculty, principle, &c. when conſidered and purſued ſufficiently, ſeems to extend itſelf into the boundaries of the others, and, as it were, to incloſe and comprehend them all. Thus magnetiſm mixes itſelf with the gravitation both of bodies upon the ſurface of the earth, and with that of the moon to the earth: a polar virtue of the ſame kind ſeems to have a principal ſhare in the formation of natural bodies, eſpecially thoſe whoſe parts cohere in regular figures: electricity may alſo extend, without being excited by friction or otherwiſe, to ſmall diſtances, and join with the juſt mentioned polar virtue, in making the parts of bodies cohere, and, in ſome caſes, in regular figures. The effervеſcence which attends the mixture of acids and alkalis, and the ſolution of certain bodies in menſtruums, fermentation, and putrefaction, are all general principles of very extenſive influence, nearly related to each other, and to the fore-mentioned mutual attractions and repulſions, and are poſſeſſed of the ſame unlimited power of propagating themſelves, which belongs to the ſeveral ſpecieſes of plants and animals. A repulſion which ſhould throw off indefinitely ſmall corpuſcles with indefinitely great velocity from all the bodies of the univerſe (a thing that would be very analogous to the emiſſion of light, odoriferous particles, and magnetical and electrical effluvia, and to the generation of air and vapour), might cauſe the gravitation of all the great bodies of the univerſe to each other, and perhaps other kinds of attraction. Some of theſe corpuſcles, by ſtopping each other in the intermundane ſpaces, or other mutually repulſive corpuſcles lodged there from cauſes not yet diſcovered, may compoſe a ſubtle vibrating medium. The vibrations of this medium, being continued to the great bodies of the univerſe, may ſo far agitate their ſmall parts, as to give their attractive and repulſive powers an opportunity to exert themſelves with great vigour; and the emiſſion of the above-mentioned corpuſcles may be, in part, occaſioned by the attractions and conſequent colliſions of ſmall parts thus agitated; ſo that elaſtic corpuſcles may be thrown off from theſe ſmall parts with indefinitely great velocity. And it would be no objection to theſe or ſuch like ſuppoſitions, that we could not explain, in any definite manner, how theſe things are effected, nor put any limits to the ſizes of decreaſing corpuſcles, or their active powers in reſpect of each other. Nor would this be to reaſon in a circle, more than when we argue, that the heart and brain, or the body and the mind, depend upon each other for their functions; which are undeniable truths, however unable we may be to give a full and ultimate explanation of them. However, it is not impoſſible, on the other hand, but future ages may analyſe all the actions of bodies upon each other, up to a few ſimple principles, by making ſuch ſuppoſitions as the phænomena ſhall ſuggeſt, and then trying and modelling them by the phænomena. At leaſt this is what one is led to hope, from the many ſimple and eaſy ſolutions of very complex problems, which have been produced within the two laſt centuries.

We may draw the following corollaries from the hypotheſis of vibrations, as laid down in the two foregoing *propoſitions*.

Corollary 1. The vibrations of the medullary particles may be affected with four ſorts of differences; viz. thoſe of degree, kind, place, and line of direction. Vibrations differ in degree, according as they are more or leſs vigorous; *i. e.* as the particles oſcillate to and fro, through a longer or ſhorter very ſhort ſpace; *i. e.* as the impreſſion of the object is ſtronger or weaker, and thus affects the medullary particles more or leſs vigorouſly, either directly and immediately, or mediately, by generating a greater or leſs degree of condenſation in the pulſes of the æther. Vibrations differ in kind, according as they are more or leſs frequent, *i. e.* more or leſs numerous, in the ſame ſpace of time. They differ in place, according as they affect this or that region of the medullary ſubſtance of the brain primarily. And they differ in the line of direction, according as they enter by different external nerves.

Cor. 2. The magnitude of each ſenſation is chiefly to be eſtimated from the vibrations which take place in the medullary ſubſtance of the brain, thoſe which are excited in the ſpinal marrow and nerves, being for the moſt part, ſo inconſiderable, in reſpect of the juſt mentioned ones, that they may be neglected.

Cor. 3. The brain may therefore in a common way of ſpeaking, be reckoned the ſeat of the ſenſitive ſoul, or the ſenſorium, in men, and all thoſe animals where the medullary ſubſtance of the nerves and ſpinal marrow is much leſs than that of the brain; and this even upon the ſuppoſition laid down in the firſt propoſition, viz. that the whole medullary ſubſtance of the brain, ſpinal marrow, and nerves, is the immediate inſtrument of ſenſation, and equally related to the ſenſitive ſoul, or principle. But if there be any reaſon to ſuppoſe, that the firſt propoſition is not ſtrictly true, but that the ſpinal marrow and nerves are only inſtruments ſubſervient to the brain, juſt as the organs of the hand, eye, ear, &c. are to them, and the brain itſelf to the ſoul, we may conclude abſolutely, that the ſenſorium of ſuch animals is to be placed in the brain, or even in the innermoſt regions of it. Now there are ſome phænomena which favour this, by ſhewing, that whatever motions be excited in the nerves, no ſenſation can ariſe, unleſs this motion penetrate to, and prevail in, the brain. Thus, when a nerve is compreſſed, we loſe the ſenſe of feeling in the part to which it leads: a perſon much intent upon his own thoughts does not hear the ſound of a clock; *i. e.* the vibrations excited by this ſound in the auditory nerve cannot penetrate to, and prevail in, the brain, on account of thoſe which already occupy it: and a perſon who has loſt a limb often feels a pain, which ſeems to proceed from the amputated limb; probably becauſe the region of the brain correſponding to that limb, is ſtill affected.

If it be certain, that ſome of the medullary parts have been diſcharged, in abſceſſes of the brain, one would incline to think, that the external parts of the *medulla* are inſtrumental, in reſpect of the internal. And, on the other hand, one may queſtion, whether, in animals of the ſerpentine form, and thoſe whoſe brains are comparatively ſmall, and in all thoſe of the polypous kind, the ſenſorium be not equally diffuſed over the whole medullary ſubſtance, or even over all the living parts. I only hint theſe things, not preſuming even to conjecture, but only to excite thoſe who have proper opportunities, to inquire carefully into theſe matters.

Cor. 4. If we allow the exiſtence of the æther, and its uſe, in performing ſenſation, thought, and motion, as it may be inferred from the two foregoing propoſitions, compared with ſuch other things as follow in theſe obſervations, in favour of the doctrine of vibrations; we may conclude, that the æther muſt have a conſiderable ſhare in the production of many other natural phænomena; and therefore ſhall have a ſufficient foundation for trying how far it will carry us, agreeably to the facts. I would recommend this, in a particular manner, to thoſe perſons who are much converſant with electrical phænomena; eſpecially as Sir *Iſaac Newton* himſelf, whoſe great caution and reſervedneſs, in difficult and doubtful matters, are ſufficiently known, has made no ſcruple to affirm, that the powers of electrical bodies are owing to the action of the æther. *See the laſt paragraph of the* Principia.

Scholium. It may be proper to remark here, that I do not, by thus aſcribing the performance of ſenſation to vibrations excited in the medullary ſubſtance, in the leaſt preſume to aſſert, or intimate, that matter can be endued with the power of ſenſation. It is common to all ſyſtems, to ſuppoſe ſome motions attendant upon ſenſation, ſince corporeal objects muſt, by their actions, impreſs ſome motion upon our bodies, and particularly upon that part which is moſt nearly related to the ſentient principle; *i. e.* upon the medullary ſubſtance, according to the firſt and ſecond propoſitions. I lay down theſe propoſitions, therefore, as eſtabliſhed by the common conſent of phyſicians and philoſophers; and upon that foundation proceed to inquire into, and determine, ſome matters of a more difficult nature; ſuch as the complex problems concerning ſenſations, ideas, and motions, and their mutual influences and relations.

The following inſtance may illuſtrate this: the quantity of matter in bodies is always found to be proportional to their gravity: we may therefore either make the quantity of matter the exponent of the gravity, or the gravity the exponent of it, according as either can be beſt aſcertained; notwithſtanding that we are entirely at a loſs to determine, in what mechanical way each atom contributes to the gravity of the whole maſs; and even though we ſhould, with ſome, ſuppoſe this effect to be immechanical, and to ariſe from the immediate agency of God. And, by parity of reaſon, if that ſpecies of motion which we term vibrations, can be ſhewn by probable arguments, to attend upon all ſenſations, ideas, and motions, and to be proportional to them, then we are at liberty either to make vibrations the exponent of ſenſations, ideas, and motions, or theſe the exponents of vibrations, as beſt ſuits the inquiry;

however impoſſible it may be to diſcover in what way vibrations cauſe, or are connected with ſenſations, or ideas; *i. e.* though vibrations be of a corporeal, ſenſations and ideas of a mental nature.

If we ſuppoſe an infiniteſimal elementary body to be intermediate between the ſoul and groſs body, which appears to be no improbable ſuppoſition, then the changes in our ſenſations, ideas, and motions, may correſpond to the changes made in the medullary ſubſtance, only as far as theſe correſpond to the changes made in the elementary body. And if theſe laſt changes have ſome other ſource beſides the vibrations in the medullary ſubſtance, ſome peculiar original properties, for inſtance, of the elementary body, then vibrations will not be adequate exponents of ſenſations, ideas, and motions. Other ſuppoſitions to the ſame purpoſe might be made; and, upon the whole, I conjecture, that though the firſt and ſecond propoſitions are true, in a very uſeful practical ſenſe, yet they are not ſo in an ultimate and preciſe one.

PROP. VI.

The Phænomena of ſenſible Pleaſure and Pain appear to be very ſuitable to the Doctrine of Vibrations.

THE moſt vigorous of our ſenſations are termed ſenſible pleaſures and pains, as noted above, in the introduction. And the vivid nature of theſe engages us to be very attentive to their ſeveral properties, relations, and oppoſitions. It is requiſite therefore, in our inquiry into the doctrine of vibrations, to examine, how far the phænomena of ſenſible pleaſure and pain can be deduced from, or explained by it.

First then, The doctrine of vibrations ſeems to require, that each pain ſhould differ from the correſponding and oppoſite pleaſure, not in kind, but in degree only; *i. e.* that pain ſhould be nothing more than pleaſure itſelf, carried beyond a due limit. For of the four differences of vibrations mentioned in the firſt corollary of the foregoing propoſition, three are given, viz. thoſe of kind, place, and line of direction, in the pleaſures and pains which correſpond, as oppoſites to each other: there is therefore nothing left, from whence the difference of ſuch pleaſures and pains can ariſe, except the difference of degree. But the phænomena appear to be ſufficiently ſuitable to this reaſoning, inaſmuch as all pleaſure appears to paſs into pain, by increaſing its cauſe, impreſſion, duration, ſenſibility of the organ upon which it is impreſſed, &c. Thus an agreeable warmth may be made to paſs into a troubleſome, or burning heat, by increaſe, or continuance; and the ſame thing holds, in reſpect of friction, light, and ſounds. And as medicinal bodies appear, from obſervations both philoſophical and vulgar, to be endued with more active properties than common aliments; *i. e.* to be fitted for exciting ſtronger vibrations; ſo their taſtes and ſmells are, for the moſt part, ungrateful; whereas thoſe of common aliments are pleaſant. It may be obſerved alſo, that ſome painful ſenſations, as they decreaſe by time, or the removal of the cauſe, paſs into poſitive local pleaſures, of the ſame ſpecies as the preceding pain; thus ſhewing the near alliance between pleaſure and pain; and that a mere difference in degree puts on the appearance of one in kind, at a certain point. I ſuppoſe it may be referred to this head, that ſome bitter and acrimonious taſtes leave an agreeable reliſh of the ſweet kind upon the tongue, after ſome time.

Secondly, It agrees well with the doctrine of vibrations, that all evident ſolutions of continuity in the living parts occaſion pain, inaſmuch as a ſolution of continuity cannot happen without a violent impreſſion of ſome ſenſible object, nor, by conſequence, without violent mutual actions between the object, nerves, and æther. The ſolution of continuity does therefore preſuppoſe that degree of violence in the vibrations, which exceeds the limit of pleaſure, and is proper to pain, according to the foregoing paragraph.

Thirdly, We may, in like manner, give a reaſon, from the doctrine of vibrations, both why a moderate degree of diſtention in the parts is neceſſary to their growth, and pleaſurable ſtate; and alſo why all great diſtentions are attended with pain for a conſiderable time, before they are raiſed to ſuch a pitch as to cauſe a viſible ſolution of continuity. For a great diſtenſion is equivalent to a vigorous impreſſion of a ſenſible object, being often cauſed by ſuch; and as the ſituation of the ſmall particles is changed in great diſtentions, their mutual actions will be changed alſo, and ſo may give riſe to more vigorous vibrations; and theſe increaſed vibrations may either fall within the limits of pleaſure, or go beyond them, according to their degree. We are alſo to conſider, that, in all conſiderable diſtentions there is an increaſe of friction between the veſſels and circulating fluids, and conſequently of heat, *i. e.* of vibrations.

But beſides this, it ſeems not improbable, that in preternatural and painful diſtentions, the ſmall particles are perpetually ſeparating themſelves from their former coheſions, and running into new ones; ſo that a minute and inviſible ſolution of continuity is carried on during the whole diſtention, till ſuch time as this degree of diſtention becomes familiar to the parts, and the ſituation and mutual actions of the ſmall particles be accommodated to it. Thus the cauſe of the pain in diſtentions will ariſe from the ſolution of continuity, and may be referred to the foregoing head. And converſely it appears, that in manifeſt ſolutions of continuity, occaſioned by wounds, burns, &c. there always ariſes in the neighbouring parts, which are inflamed, a preternatural diſtention of the ſmall fibres and veſſels; by which means the pain is renewed and continued. Every manifeſt ſolution of continuity does therefore, according to the explanation of diſtention juſt laid down, include within itſelf an infinite number of minute inviſible ſolutions.

Hence we may aſk, whether this minute inviſible ſolution of continuity in the infiniteſimal medullary particles of the brain, is not that common limit, and middle point, which ſeparates pleaſure from pain, and of which the viſible ſolutions of continuity, which are cauſed by external injuries, are a type, and alſo a means, viz. by propagating violent vibrations up to the brain. It is ſome preſumption in favour of this poſition, that all conjectures concerning inviſible things ought to be taken from viſible ones of the ſame kind; alſo that it is particularly ſuitable to the doctrine of vibrations; inaſmuch as, laying down this doctrine, one may eaſily conceive how moderate and pleaſant impreſſions may agitate the medullary particles in ſo moderate a degree, as that they ſhall again return to their former ſituations and connections, when the agitation is over; whereas violent and painful ones may force the particles from thence, and give riſe to new ones; *i. e.* to the ſolution of continuity. And as the body is ſo formed, that great and viſible ſolutions of continuity may be healed again, and the parts reſtored, in great meaſure, to their primitive integrity and perfection, by the power of nature, unleſs where there is a loſs of ſubſtance (and yet even here the ſame end is obtained in part); ſo we may ſuppoſe, that the power of nature reſtores all minute ſolutions of continuity in the conſtituent, infiniteſimal particles, almoſt inſtantaneouſly, and ſo that the body receives no perceptible detriment from ſingle inſtances, though it probably does from frequent repetitions; agreeably to which, it is generally ſuppoſed, that pain, by often returning, impairs the faculties, both bodily and mental.

Fourthly, The bones, nails, hair, and cuticle, may conſiſtently with the doctrine of vibrations, have a ſolution of continuity produced in their parts, without pain enſuing; for they are hard and therefore incapable, as it ſeems, of receiving and communicating to the contiguous nerves, and thence to the brain, vibrations of any conſiderable degree of ſtrength. We are alſo to ſuppoſe, that in palſies, mortifications, &c. changes of texture of ſomewhat a like kind, are produced, ſo as to render the parts affected thereby incapable of conveying ſenſation to the medullary ſubſtance of the brain. Old age, inactivity, inflammation, pain, &c. are in like manner to be conſidered, as inducing ſuch a degree of condenſation, fixation, and calloſity, in the medullary ſubſtance itſelf, as muſt end at laſt in inſenſibility and death.

Fifthly, It is not unſuitable to the doctrine of vibrations, that the frequent repetition of the ſame external impreſſions ſhould have the power of converting original pains into pleaſures, and pleaſures into mere ſenſations, *i. e.* into evaneſcent pleaſures; as we find it has in fact. For this may be effected by ſuch a change in the organ and brain, as that the organ ſhall ſend weaker and weaker vibrations perpetually to the brain, upon every ſucceſſive renewal of the ſame impreſſion, and the brain become perpetually leſs and leſs diſpoſed to receive ſtrong vibrations, though the power of communication from the impreſſions ſhould continue the ſame. It remains therefore to be inquired, what general tendencies in the ſmall medullary particles, might diſpoſe them to undergo ſuch changes. And it appears to me, that a change of the ſpheres of attraction and repulſion in theſe particles, upon every change in their ſituations, ſo as always to lean towards the ſituation laſt ſuperinduced, might be ſufficient for this purpoſe. However, this is a mere ſuppoſition, and that of a very recluſe nature. Only let it be obſerved, that the fact to be here accounted for, viz. the decreaſe in the efficacy of impreſſions frequently repeated, is both an evident one, and alſo muſt have its riſe from ſome powers in the ſmall parts of matter over each other. It muſt therefore admit of an explanation, either from the doctrine of vibrations, or from ſome other law of matter and motion. And if the doctrine of vibrations be found ſuitable to other phænomena, it may be preſumed not to be unſuitable to this, till ſuch time as ſome manifeſt inconſiſtency between them ſhall appear.

It ought to be remarked here, that this tranſit of original pains into pleaſures, and of vivid pleaſures into faint ones, by frequent repetition, bears ſome relation to the above-mentioned tranſition of pains into poſitive local pleaſures, of the ſame kind with themſelves.

To this head of conſideration may be referred Dr. *Jurin's* obſervation, viz. "That when we have been "for ſome time affected with one ſenſation, as ſoon "as we ceaſe to be ſo affected, a contrary ſenſation is "apt to ariſe in us, ſometimes of itſelf, and ſometimes "from ſuch cauſes, as at another time would not pro"duce that ſenſation at all, or, at leaſt, not to the "ſame degree." For the continued impreſſion of the ſame object will ſo fix upon the ſenſory nerve, and region of the brain correſponding thereto, a tendency to one peculiar ſort of vibrations, that an impreſſion of an oppoſite, or very different ſort, muſt do more than uſual violence to the brain, *i. e.* will excite a glaring ſenſation of an oppoſite nature. *See the Inſtances mentioned by Dr.* Jurin, *in his Eſſay on diſtinct and indiſtinct viſion.*

Sixthly, We may account for the different kinds and degrees of pleaſure and pain, from the four differences of vibrations mentioned above, viz. thoſe of degree, kind, place, and line of direction, and their various combinations with each other. For it is obvious to conceive, that theſe combinations may be ſufficiently numerous and diſtinct from each other, to anſwer to the facts. If the vibrations go beyond the common limit of pleaſure and pain in one part of the brain, at the ſame time that they fall ſhort of it in others, the reſult will be a pleaſure or pain, according as this or that ſort of vibrations prevails; and if they be nearly equal, it will be difficult to determine of which kind it is. If the vibrations fall a little ſhort in all the parts, they will generate a high degree of pleaſure; which, however, muſt be leſs than the leaſt general pain, *i. e.* ſuch a one wherein the vibrations go beyond the limits in all the parts: but it may be far greater than partial pains, or than thoſe which affect only one particular region of the brain. Hence we may ſee, that the pains are in general greater than the pleaſures; but then they are more rare for the ſame reaſon, being ſuch violent ſtates as cannot ariſe from common impreſſions. Or, if we ſuppoſe the pains to be frequent, they will then ſo far alter the diſpoſition of the medullary ſubſtance, according to what was ſaid above, as that many original pains will be converted into pleaſures: which indeed ſeems to be the caſe not unfrequently; for the organs of the new-born infant are ſo delicate, as to receive pain from many of thoſe impreſſions which afterwards yield pleaſure. But then, his ſources of pleaſure ſeem to be multiplied more than in proportion to what he ſuffers by this previous paſſage through pain.

In certain caſes of exceſſive pains, the violent vibrations appear at laſt to excite a latent attractive power in the medullary particles, in the manner hereafter to be deſcribed, in reſpect of the fibres of the muſcles and membranes, which puts a ſtop to thoſe very vibrations that excited it. Hence faintings and ſtupors, *i. e.* the ceſſation of pain from violent pains. However, a greater degree of vibrations is probably required for exciting this attractive power in the medullary particles than in white fibres, and in white fibres than in red ones, as will appear hereafter.

It follows alſo, from the principles here laid down, that all the pleaſures, though particularly different from each other, ought to have a general reſemblance, in their circumſtances and conſequences: and the pains likewiſe.

Seventhly, All the mere ſenſations, which enter the mind by the five external ſenſes, admit of a general analyſis, upon the ſame principles as the pleaſures and pains do. For all the mere ſenſations were, in their original ſtate, either pleaſures or pains, and vary now from their original ſtate only by the diminution of the degree. Let therefore all the differences of kind, place, and line of direction, be combined in all their varieties, the degree being ſuppoſed every where evaneſcent; and we ſhall have all the particular vibrations from whence each mere ſenſation ariſes. This is the general account. But it is a moſt difficult problem to explain, by what differences of kind the particular ſenſations, either of the ſame, or of different ſenſes, are diſtinguiſhed from each other.

It ſeems probable to me, that the limits of the ſeven primary colours, viz. the extreme red, the limit of the red and orange, of the orange and yellow, yellow and green, green and blue, blue and indigo, indigo and violet, and the extreme violet, excite vibrations in the optic nerve, whoſe times are proportional to the times of vibration of a ſtring which ſounds the notes in order, according to the key mentioned by Sir *Iſaac Newton* in his *Opticks*, *i. e.* the notes D, E, F, G, A, B, C, D. This hypotheſis affords at leaſt a probable reaſon for the ſeveral very particular breadths of the primary colours,

lours, in the priſmatic oblong image of the ſun, as I ſhall endeavour to ſhew in its place, *Prop.* 56.

If the frequency of the vibrations excited by the ſeveral ſapid and odorous bodies in the nerves of the tongue and membrana ſchneideriana, could be diſcovered, it is not improbable but this would be a clue to lead us into the inner conſtitution of natural bodies; ſince one may reaſonably ſuppoſe, that each ſapid and odorous body excites vibrations of the ſame frequency as thoſe which take place in it before it is taſted or ſmelt to.

The ſolution of the ſame problem, in the ſeveral ſenſes, might alſo a little unfold to us the different internal ſtructure of the ſeveral nerves, and of the parts of the brain that correſpond thereto. For it ſeems probable to me, that each nerve and region is originally fitted to receive, and, as one may ſay, ſympathize with, ſuch vibrations as are likely to be impreſſed upon them in the various incidents of life; and not that the auditory nerve could perform the office of the optic, if put into its place, or *vice verſâ*, &c. according to *Rów*.

Eighthly, It is obſerved by medical writers, that pain is apt to excite a contraction in the fibres of the neighbouring membranes. Now this is very agreeable to that power which ſenſory vibrations have, in general, over the red fleſhy muſcles, for contracting them in the manner to be deſcribed hereafter. For ſince vibrations of a middle ſtrength, by deſcending into the red fibres of the muſcles, are ſufficient to contract them in the ordinary functions and actions of life, it is not unreaſonable to expect, that the ſtronger vibrations which attend pain, ſhould be ſufficient to contract the pale fibres of membranes, though theſe be in themſelves of a leſs contractile diſpoſition.

It is agreeable to this, that titillation and itching, which lie, as it were, upon the confines of pleaſure and pain, are more apt to diffuſe themſelves over the neighbouring parts than pain. For titillation and itching only agitate the ſmall particles of the membranes, and therefore run along their ſurfaces, by the ſucceſſive communication of theſe agitations; whereas pain, by contracting the fibres, puts a ſtop to theſe agitations, and conſequently to its own diffuſion over the neighbouring parts.

Ninthly, Extreme and pointed parts, ſuch as the extremity of the noſe, the uvula, the epiglottis, the nipples, and the ends of the fingers, are in general more ſubject to irritation, itching, and inflammation, and endued with a greater degree of ſenſibility than the other parts. Now this phænomenon agrees with the doctrine of vibrations, inaſmuch as ſuch parts muſt, according to the *Newtonian* hypotheſis, be ſurrounded with an æther of a greater denſity than that within their pores, and which alſo grows denſer and denſer, in a regular manner. For one may conceive, that the vibrations communicated to this denſer æther, will be ſtronger in proportion to its denſity; and conſequently, that they will agitate the ſmall particles of the extreme parts alſo with vibrations ſtronger than ordinary.

It is true, indeed, that the ſenſibility of each part does depend, in great meaſure, on the number, ſtructure, and diſpoſition of the nervous papillæ, which are the immediate organ in the ſenſes of feeling, taſte, and ſmell; but then we may remark, that the ſame obſervation holds in reſpect of theſe nervous papillæ. For they are alſo extreme and pointed parts, and that eſpecially, if we ſuppoſe, which ſeems probable, that when any part is in a ſtate of exquiſite ſenſibility, the nervous papillæ are erected (in ſome ſuch manner as the hairs of the neck and back in certain animals, when enraged), ſo as to recede from each other, and conſequently, to admit the denſer æther between them. They may alſo, upon the ſame occaſions, be made turgid, by the conſtriction of their baſes, and thus have their ſenſibility, or power of receiving vibrations, increaſed by diſtention.

We may remark likewiſe, in purſuing this method of reaſoning, that the æther which lies contiguous to the medullary ſubſtance in the ventricles of the brain, is denſer than that which lies in the medullary ſubſtance itſelf. May we not therefore conjecture, that one uſe of the cavities of the ventricles is to increaſe and keep up all the vibrations propagated from the external nerves into the medullary ſubſtance of the brain, by means of the denſer æther lodged in thoſe cavities; that blood and ſerum extravaſated, and lying in the ventricles, ſuffocate ſenſations, by excluding this denſer æther as well as by preſſing on the medullary ſubſtance; and, laſtly, that thoſe brutes whoſe olfactory nerves have cavities within them continued from the ventricles, are more acute than men, in perceiving odours, and diſtinguiſhing them from each other, in part, upon this account? *Boerhaave* is, indeed, of opinion, that the oppoſite ſides of the ventricle always touch each other, ſo as to leave no cavity. But it ſeems more reaſonable to ſuppoſe, that a ſubtle vapour, which is exhaled from the veſſels of the inveſting membrane, and whoſe particles, like the vapour of water, have a repulſive power, in reſpect of each other, prevents the abſolute mutual contact of the oppoſite ſides, in common caſes. And the ſame thing is favoured by the experiments tried upon the *Pariſian* beggar. Since the brain in him could be ſomewhat preſſed in, it ſeems that the ſkull was not entirely full before.

PROP.

PROP. VII.

The Phænomena of Sleep appear to be very ſuitable to the Doctrine of Vibrations.

HERE I obſerve, firſt, that new-born children ſleep almoſt always. Now this may be acccounted for by the doctrine of vibrations, in the following manner: the fœtus ſleeps always, having no ſenſation from without impreſſed upon it, and only becomes awake upon its entrance into a new world, viz. by means of the vigorous vibrations which are impreſſed upon it. It is reaſonable therefore to expect, that the new-born child ſhould fall back into its natural ſtate of ſleep, as ſoon as theſe vibrations ceaſe, and return again to a ſtate of vigilance, only from the renewal of vigorous impreſſions; and ſo on alternately, agreeably to the fact.

Secondly, Even adults are diſpoſed to ſleep, when the impreſſions of external objects are excluded, and their bodies kept in a ſtate of reſt, for the ſame reaſons as thoſe juſt mentioned in the ſimilar ſtate of young children. However, they incline more to vigilance than children, partly becauſe their ſolids and fluids are more active, and leſs compreſſible, *i. e.* more ſuſceptible and retentive of vibrations; and partly, becauſe aſſociation brings in perpetual trains of ideas, and conſequently of vibrations, ſufficiently vivid to keep up vigilance in common caſes.

Thirdly, Having preſented the reader with the two foregoing obſervations, which are of a very obvious kind, I will now inquire with more minuteneſs, into the intimate and preciſe nature of ſleep. It appears then, that, during ſleep, the blood is accumulated in the veins, and particularly in the venal ſinuſes which ſurround the brain and ſpinal marrow; and alſo, that it is rarefied, at leaſt for the moſt part.

For as the actions of the muſcles ſqueeze the blood out of the veins during vigilance, ſo their inactivity during ſleep ſuffers the blood to lodge in the veins; and the decumbent poſture, which is common to animals in ſleep, ſuffers it to lodge particularly in the venal ſinuſes of the brain and ſpinal marrow. And it is agreeable to this, that, in moſt diſſections, the blood is found chiefly in the veins, and, in diſſections after lethargies, apoplexies, &c. the venal ſinuſes of the brain, and conſequently thoſe of the ſpinal marrow, which communicate freely with them, are particularly full. As to the rarefaction of the blood, it follows from the warmth of the body, which is an uſual attendant upon ſleep, and is cauſed by the reſt of the body, the warmth of the place where the perſon ſleeps, the coverings, and the fermentative diſpoſition of the freſh chyle, which then enters the blood. It follows therefore, that the brain and ſpinal marrow will be particularly compreſſed during ſleep, ſince the blood then takes up more ſpace, is particularly accumulated within the cavities of the ſkull and vertebræ, and the hardneſs of theſe bones will not ſuffer them to yield or make more room. It follows alſo, that the ſoftneſs of the medullary ſubſtance will ſubject it to the effects of this compreſſion, more than the cortical; ſo that, if we ſuppoſe its functions to conſiſt in receiving, retaining, and communicating vibrations, it will be rendered peculiarly unfit for theſe functions, from the compreſſion here mentioned, *i. e.* the animal will be indiſpoſed to ſenſation and motion, agreeably to obſervation.

There are many other arguments which might be brought to ſhew, that during ſleep, and ſleepy diſtempers, the brain is particularly compreſſed, if it were neceſſary. But the inſtance of the *Pariſian* beggar, above noted, is moſt to this purpoſe. This perſon had a perforation in his ſkull, which did not oſſify; whence, by external preſſure upon that part, the internal regions of the brain might be affected; and it was conſtantly obſerved, that, as the preſſure increaſed, he grew more and more ſleepy, and at laſt fell into a temporary apoplexy.

In young children, there ſeems to be a conſtant moderate preſſure of the ſkull upon the brain. For the brain is of a great relative magnitude in them, and, by its endeavour to expand itſelf, it keeps the ſutures from uniting too firmly, till ſuch time as it is arrived at its full growth. It muſt therefore be compreſſed in return, by the re-action of the ſkull. And this may be conſidered as a circumſtance, which concurs to render young children more apt to ſleep than adults. When old perſons are ſleepy, it is a morbid affection, and may ariſe either from an hydropical diſpoſition, whereby the turgeſcence of the neighbouring parts compreſſes the medullary ſubſtance; or from a defect of nutrition in this ſubſtance, which renders it ſoft and compreſſible in a preternatural degree. If the venal ſinuſes, and other blood veſſels, of the brain, be, by any accident preternaturally diſtended, and continue ſo for a conſiderable time, they will ſcarce ever recover their priſtine tone and dimenſions; and this ſo much the more, as the perſon approaches to old age.

For the ſame reaſon, as the medullary ſubſtance within the ſkull and vertebræ is compreſſed during ſleep, that of the ganglions, plexuſes, and trunks of the nerves in other parts of the body, will be compreſſed alſo, though in a leſs degree. For this ſubſtance has no blood or groſs fluids within it, and is far the ſofteſt of all the parts of the body; and the membranes, which inveſt all the parts of the body, perform the ſame office to them, in a leſs degree, as the ſkull does to the brain, *i. e.* check their diſtention. The ſurrounding membranes muſt therefore compreſs the ſoft medullary ſubſtance in the ganglions,

glions, plexuſes, and trunks of the nerves, during ſleep, on account of the rarefaction of the humours at that time; whence, according to the doctrine of vibrations, ſenſory ones can neither aſcend freely from the external organs to the brain, nor motory ones deſcend into the limbs, *i. e.* the animal will be inſenſible and inactive, as it is found to be in fact.

Is it not probable, that, as ſleep comes on, the oppoſite ſides of the ventricles of the brain approach towards each other, on account of the compreſſion here aſſerted; alſo, that they become contiguous at the inſtant of ſleep, excluding the denſer æther, mentioned in the foregoing propoſition, thereby? By this means, the power of ſenſation would receive a remarkable diminution at the inſtant of falling aſleep, as it ſeems to do. There might alſo in certain circumſtances, ariſe a very vivid exertion of the perceptive and motive faculties at that inſtant, from the compreſſion of the æther previous to its rarefaction, ſuch as would account for the ſudden terrors and ſtartings which happen at the inſtant of going to ſleep, in ſome morbid caſes.

Fourthly, It is obſerved, that vigilance continued fatigue, and pain, all diſpoſe ſtrongly to ſleep. For all vigorous or long-continued vibrations muſt both generate heat, whereby the blood and juices will be rarefied, ſo as to compreſs the medullary ſubſtance, and alſo exhauſt this ſubſtance of its fluid and active particles, ſo as to render it more eaſily compreſſible, and leſs ſuſceptible and retentive of vibrations. Great degrees of heat ſeem to produce an extraordinary propenſity to ſleep, in nearly the ſame way.

And when perſons expoſed to extreme cold are overcome by a pleaſing, but fatal ſleep, it ſeems as if the internal parts were affected with a preternatural warmth, from the vigorous ſenſations and concomitant vibrations impreſſed on the external parts by the cold, and thence aſcending to the brain. It agrees

with

Or more probably, the superficial vessels being ~~[illegible]~~ contracted by cold, the blood is driven in greater quantity into the more internal ~~[illegible]~~ vessels, thereby distending them, & compressing ye neighbouring parts with the hypotheſis here propoſed, that theſe uneaſy ſenſations decline by degrees, till they fall within the limits of pleaſure, and, at laſt, end in inſenſibility. This ſleep may prove fatal, from the great difference between the internal and external parts, in reſpect of heat; alſo from the cold's penetrating farther and farther. Muſcular motion may prevent it, and its ill effects, partly as the veins are emptied by this, partly as it warms the external parts, and cools the internal, from the return of the cool blood into the courſe of the circulation. If we ſuppoſe the circulation to ceaſe entirely, at the ſurface of the body from the cold, then will warm blood circulate through the internal parts alone; and theſe parts will continue to be defended from the cold by the external ones, for a time. And thus the body will approach to the common ſtate of a perſon going to ſleep.

It is eaſy to ſee, from the method of reaſoning here uſed, how perſons recovering from long illneſſes ſhould be much diſpoſed to ſleep, viz. from the exhauſtion of the medullary ſubſtance, their almoſt conſtant reſt, their being kept warm, and the frequent taking ſuſtenance, ſo as to beget great quantities of freſh chyle, and conſequently, an extraordinary degree of a fermentative heat.

Fifthly, The manner in which opiates produce ſleep may be thus explained, agreeably to the doctrine of vibrations. Opiates evidently excite grateful ſenſations in the ſtomach and bowels. This appears from the ſhort time in which liquid opiates take effect; and even from immediate and direct ſenſations: a perſon may even feel, that the ſtomach is the ſeat of the pleaſurable impreſſions made by opiates. We are to ſuppoſe therefore, that vivid vibrations, which, however, lie within the limits of pleaſure, aſcend perpetually from the ſtomach and bowels along the par vagum, and intercoſtal nerves, up to the brain and ſpinal marrow, diffuſe themſelves over theſe, and from thence deſcend along the nerves into all the parts of the body. Hence it follows, that they will obſcure and over-power all moderate ſenſations, or vibrations, which ſubſiſted before, or which external objects may from time to time endeavour to excite, and introduce a general pleaſurable ſtate over the whole nervous ſyſtem; with trains of pleaſurable ideas, in the manner to be explained hereafter, when we come to treat of ideas, their generations, aſſociations, and dependencies on bodily ſtates. During this pleaſurable ſtate, the body will of courſe be compoſed to reſt; reſtleſſneſs, toſſings, and changes of poſture, being cauſed, for the moſt part, by uneaſy ſenſations. Hence the blood will be accumulated in the veins and venal ſinuſes, and grow warm both from the vigorous vibrations excited by the opiate, and from the abſolute reſt of the body. For abſolute reſt conduces, in a peculiar manner, to make the body grow warm, by the heat reflected from the contiguous coverings; as, on the contrary, the ſlighteſt motions frequently returning, ventilate and cool the parts. And thus the compreſſion of the medullary ſubſtance requiſite for ſleep, will be induced by the action of the opiate upon the ſtomach and bowels.

But, beſides this, we may conceive, that the opiate particles excite vibrations of the ſame kind in all the parts of the body, after they are taken into the blood, and circulate with it, till ſuch time as, by a perfect aſſimilation, they loſe all their peculiar qualities.

It ſeems alſo, that the continued deſcent of vibrations, from the brain, and ſpinal marrow, into the limbs, and external parts, agitates them ſo much, as to render them unfit for receiving ſenſation and motion, in the ſame manner as continued friction of the head, when newly ſhaved, or ſhaking the hand, occaſion a kind of numbneſs in the head and hand reſpectively. For a diſorder raiſed in the motory nerves, and muſcular fibres, analogous to numbneſs in the ſenſory nerves, and ſentient papillæ, muſt produce ineptitude to motion. It ſeems therefore, that the inſenſibility and immobility which proceed from opiates, and which concur in haſtening the ſleep, and increaſing its degree, ariſe in great part from this cauſe. The numbneſs, and paralytic weakneſſes, which frequently ſucceed after opiates, are evidences for what is here alleged.

Opium ſeems to have an intermediate degree of activity between narcotics, or ſtupefying poiſons, on one hand, and grateful aliments, particularly vinous liquors, on the other. Narcotics operate ſo violently on the ſtomach and bowels, the brain, and the external parts, as to bring confuſion on the ſenſations, and trains of ideas, and convulſions on the muſcular ſyſtem. And that theſe effects are produced by a local influence on the ſtomach, in the manner propoſed concerning opiates, appears, becauſe they ceaſe, or abate much, ſoon after the narcotic is ejected by vomiting; alſo becauſe whipping a dog, after he has taken the nux vomica, contributes to obviate its ill effects. Wines, and grateful aliments, diſpoſe to ſleep, partly by their immediate effects on the ſtomach, partly by their effects after they are abſorbed. But the degree not being ſo great as in opiates, it may more eaſily be overcome by a variety of common or vigorous impreſſions; in which caſe the vivid vibrations excited by the wine, or aliment, will illuminate all the impreſſions, and add ſtrength to all the motions. The ſame thing is obſerved of opiates, in thoſe who take them frequently.

Sixthly, Chylification, ſanguification, nutrition, and growth, ſeem to proceed beſt during ſleep. This may be conjectured from the ſleepineſs of all animals after eating, ſince ſleep and chylification, &c. muſt here concur; and from the almoſt conſtant ſleep of new-born children, above taken notice of, ſince nature ſeems chiefly intent on the due performance of theſe functions, for ſome time after birth. Now the doctrine of vibrations may be made to illuſtrate theſe points, in ſome meaſure. For ſince reſpiration becomes ſtrong and convulſive at the inſtant of going to ſleep, it will renew and increaſe the vibrations excited in the nerves of the ſtomach and bowels by their contents, which we muſt ſuppoſe to have languiſhed before, in the ſame manner as thoſe which ſubſiſted in the external ſenſes. The organs of digeſtion therefore, as well as thoſe of reſpiration, are in a ſtate of vigilance, and are intent upon the performance of their proper functions, while the other parts are in a ſtate of ſleep and inaction, and recruiting, in order to perform their functions in a due manner, upon a return of vigilance. And this holds moſt particularly in reſpect of the medullary ſubſtance of the brain, ſpinal marrow, and nerves, which, by the conſent of all, is the chief inſtrument of nutrition and growth. Since the vibrations which take place in it during ſleep are languid, it will then be filled and recruited, and conſequently fitted for nutrition and growth; which will be farther favoured by the concurrence of a complete chylification and ſanguification, at the ſame time.

The increaſed convulſive reſpiration, and increaſed force of the heart, which take place at the inſtant of going to ſleep, and continue frequently during ſleep, may perhaps be thus accounted for, agreeably to the doctrine of vibrations. When vivid vibrations ceaſe in the external ſenſes, and regions of the brain belonging to them, alſo in the muſcles of the limbs, and parts of the ſpinal marrow correſponding thereto, this abatement of vibrations muſt either extend to the whole medullary ſubſtance, which ſeems to be the caſe in the night-mare; or if the nerves of the heart, and organs of reſpiration, and the regions of the brain and ſpinal marrow correſponding thereto, be exempted, they may be agitated even with more vigorous vibrations, on account of the abatement in the other parts, becauſe the vibrations raiſed in theſe regions during ſleep, by ſuch of their cauſes as take place then, will be hindered from diffuſing themſelves freely, and abating their own force thereby, as ſoon as the other regions are collapſed and compreſſed. Theſe cauſes are, firſt, the heat of the blood, and pulſation of the arteries of the medullary ſubſtance; both which, when increaſed on any account, muſt farther increaſe themſelves by a reflected influence, ſince both increaſe the force of the heart. Secondly, the fulneſs and diſtention of the lungs. Theſe ariſe from the rarefaction of the blood, and accumulation of it in the veins juſt before ſleep (at which time reſpiration is languid), and muſt at laſt ſtimulate the organs of reſpiration to a vigorous exertion of themſelves, *i. e.* raiſe vigorous vibrations in the region of the brain correſponding thereto, juſt as in the caſes of ſighing, and recovering from the night-mare. Thirdly, we may ſuppoſe, that the heart, and muſcles of reſpiration, do not exert themſelves during vigilance, with a degree of force at all approaching to their utmoſt powers, as the limbs do; and therefore, that they, and the correſponding regions of the brain, may be qualified for a vigorous exertion during ſleep. Fourthly, an increaſe in the force of reſpiration muſt alſo increaſe the force with which the heart moves, becauſe it propels the blood in greater quantities upon the heart. Fifthly, an increaſe of force in the heart muſt increaſe both itſelf, and the action of reſpiration, becauſe the blood veſſels of the heart and organs of reſpiration are particularly near to the heart, and therefore muſt be particularly under its influence.

Corollary 1. By laying together what has been delivered concerning ſleep, in this propoſition, the difference between the ſtates of ſleep and vigilance may be thus ſet before the reader, in one view. In ſleep, the nerves of the five external ſenſes are indiſpoſed to receive vibrations, and the objects themſelves are either abſent, or impreſſed feebly. The nerves of the ſtomach and bowels ſympathize with theſe at firſt, but recover themſelves at the inſtant of ſleep, the impreſſions of the aliment, &c. being then made with unuſual vigour; and this continues during the time of ſleep. In like manner the muſcular ſyſtem becomes inactive in general; the heart, however, and muſcles of reſpiration, are excepted, and even exert themſelves with an extraordinary degree of force. The blood is rarefied ſo as to take up more ſpace upon the whole; and as there is more in the veins, and particularly in thoſe of the brain, and ſpinal marrow, than in a ſtate of vigilance, the medullary ſubſtance is hereby expoſed to a conſtant uniform compreſſion; whereas, in vigilance, the action of the muſcles ſqueezes the blood out of the veins, and cools it, unleſs this action be violent, or long continued. The glands are filled during ſleep, and conſequently, by drawing off from the fulneſs of the blood veſſels, prepare the body for vigilance, and are themſelves fitted for the functions to be then performed, *i. e.* to excrete their proper fluids from muſcular compreſſion, or vibrations running up their excretory ducts, in the manner to be hereafter explained. The medullary ſubſtance is, in like manner, fitted and prepared for vigilance, whether it be of a glandular nature, or not. However, ſome vibrations muſt take place in it throughout, and they are particularly vivid in the regions correſponding to the heart, organs of reſpiration, and organs of digeſtion; alſo in the regions correſponding to the eye and ear, where they excite the trains of images which are preſented to us in our dreams. But the nature of theſe cannot be unfolded till we have treated of ideas, their generation and aſſociations, and the nature of true and erroneous judgments, aſſent, diſſent, imagination and memory.

Cor. 2. It appears alſo to follow, from the foregoing account of ſleep, and the effect of heat, labour, pain, and opiates, in diſpoſing to it, that, in many caſes of ſleep, the medullary ſubſtance tends to a ſubtle kind of inflammation, and is preſerved from it, and reſtored to its natural ſtate, and degree of heat, by means of ſleep ſufficiently continued. Thus, in the acceſs of moſt fevers, the patient is liſtleſs and ſleepy, the external ſenſes, muſcles, and brain, being affected, in ſome reſpects, as by opiates. If the patient ſleeps, the diſtemper is cut ſhort; but if the ſubtle inflammation be ſo great as to prevent that, the diſtemper increaſes, and comes to its period in ſome other way, according to the nature of the fever, and circumſtances of the patient. In a *coma vigil* it ſeems to me, that the approach of the oppoſite ſides of the ventricles excites ſuch violent vibrations, on account of the inflammation of the medullary ſubſtance, perhaps of theſe ſides particularly, as to awake the patient, and throw him into great confuſion and conſternation. In a frenzy, the medullary ſubſtance itſelf ſeems to labour under an acute temporary inflammation, the other parts having often no more than a due heat, whereas, in the delirium of a fever, the medullary ſubſtance only ſympathizes with the other parts. If the inflammation of the medullary ſubſtance be very ſubtle, moderate, and permanent, madneſs of ſome ſpecies enſues. And it ſeems to agree very well with the theory here propoſed, that in deliriums, frenzies, and ſome kinds of madneſs, the patient does not ſleep at all, or, if he does, in a quiet manner, is freed from his diſtemper; and that, in other kinds of madneſs, and in caſes of melancholy, the ſleep is very deep, and the patient extremely ſluggiſh.

SECT. II.

OF IDEAS, THEIR GENERATION AND ASSOCIATIONS; AND OF THE AGREEMENT OF THE DOCTRINE OF VIBRATIONS WITH THE PHÆNOMENA OF IDEAS.

PROP. VIII.

Senſations, by being often repeated, leave certain Veſtiges, Types, or Images, of themſelves, which may be called, Simple Ideas of Senſation.

I TOOK notice in the introduction, that thoſe ideas which reſemble ſenſations were called ideas of ſenſation; and alſo that they might be called *ſimple* ideas, in reſpect of the intellectual ones which are formed from them, and of whoſe very eſſence it is to be *complex*. But the ideas of ſenſation are not entirely ſimple, ſince they muſt conſiſt of parts both co-exiſtent and ſucceſſive, as the generating ſenſations themſelves do.

Now, that the ſimple ideas of ſenſation are thus generated, agreeably to the propoſition, appears, becauſe the moſt vivid of theſe ideas are thoſe where the correſponding ſenſations are moſt vigorouſly impreſſed, or moſt frequently renewed; whereas, if the ſenſation be faint, or uncommon, the generated idea is alſo faint in proportion, and, in extreme caſes, evaneſcent and imperceptible. The exact obſervance of the order of place in viſible ideas, and of the order of time in audible ones, may likewiſe ſerve to ſhew, that theſe ideas are copies and offſprings of the impreſſions made on the eye and ear, in which the ſame orders were obſerved reſpectively. And though it happens, that trains of viſible and audible ideas are preſented in ſallies of the fancy, and in dreams, in which the order of time and place is different from that of any former impreſſions, yet the ſmall component parts of theſe trains are copies of former impreſſions; and reaſons may be given for the varieties of their compoſitions.

It is alſo to be obſerved, that this propoſition bears a great reſemblance to the third; and that, by this reſemblance, they ſomewhat confirm and illuſtrate one another. According to the third propoſition, ſenſations remain for a ſhort time after the impreſſion is removed; and theſe remaining ſenſations grow feebler and feebler, till they vaniſh. They are therefore, in ſome part of their declenſion, of about the ſame ſtrength with ideas, and, in their firſt ſtate, are intermediate between ſenſations and ideas. And it ſeems reaſonable to expect, that, if a ſingle ſenſation can leave a perceptible effect, trace, or veſtige, for a ſhort time, a ſufficient repetition of a ſenſation may leave a perceptible effect of the ſame kind, but of a more permanent nature, *i. e.* an idea, which ſhall recur occaſionally, at long diſtances of time, from the impreſſion of the correſponding ſenſation, and *vice verſâ.* As to the occaſions and cauſes, which make ideas recur, they will be conſidered in the next propoſition but one.

The method of reaſoning uſed in the laſt paragraph, is farther confirmed by the following circumſtance; viz. that both the diminutive declining ſenſations, which remain for a ſhort ſpace after the impreſſions of the objects ceaſe, and the ideas, which are the copies of ſuch impreſſions, are far more diſtinct and vivid, in reſpect of viſible and audible impreſſions, than of any others. To which it may be added, that, after travelling, hearing muſick, &c. trains of vivid ideas are very apt to recur, which correſpond very exactly to the late impreſſions, and which are of an intermediate nature between the remaining ſenſations of the third propoſition, in their greateſt vigour, and the ideas mentioned in this.

The ſenſations of feeling, taſte, and ſmell, can ſcarce be ſaid to leave ideas, unleſs very indiſtinct and obſcure ones. However, as analogy leads one to ſuppoſe, that theſe ſenſations may leave traces of the ſame kind, though not in the ſame degree, as thoſe of ſight and hearing; ſo the readineſs with which we reconnoitre ſenſations of feeling, taſte, and ſmell, that have been often impreſſed, is an evidence, that they do ſo; and theſe generated traces or diſpoſitions of mind may be called the ideas of feeling, taſte, and ſmell. In ſleep, when all our ideas are magnified, thoſe of feeling, taſte, and ſmell, are often ſufficiently vivid and diſtinct; and the ſame thing happens in ſome few caſes of vigilance.

PROP. IX.

Senſory Vibrations, by being often repeated, beget in the medullary Subſtance of the Brain, a Diſpoſition to diminutive Vibrations, which may alſo be called Vibratiuncles and Miniatures, correſponding to themſelves reſpectively.

This correſpondence of the diminutive vibrations to the original ſenſory ones, conſiſts in this, that they agree in kind, place, and line of direction; and differ only in being more feeble, *i. e.* in degree.

This propoſition follows from the foregoing. For ſince ſenſations, by being often repeated, beget ideas, it cannot but be that thoſe vibrations, which accompany ſenſations, ſhould beget ſomething which may accompany ideas in like manner; and this can be nothing but feebler vibrations, agreeing with the ſenſory generating vibrations in kind, place, and line of direction.

Or thus: By the firſt propoſition it appears, that ſome motion muſt be excited in the medullary ſubſtance, during each ſenſation; by the fourth, this motion is determined to be a vibratory one: ſince therefore ſome motion muſt alſo, by the ſecond, be excited in the medullary ſubſtance during the preſence of each idea, this motion cannot be any other than a vibratory one: elſe how ſhould it proceed from the original vibration attending the ſenſation, in the ſame manner as the idea does from the ſenſation itſelf? It muſt alſo agree in kind, place, and line of direction, with the generating vibration. A vibratory motion, which recurs t times in a ſecond, cannot beget a diminutive one that recurs $\frac{1}{2}t$, or $2t$ times; nor one originally impreſſed on the region of the brain correſponding to the auditory nerves, beget diminutive vibrations in the region correſponding to the optic nerves; and ſo of the reſt. The line of direction muſt likewiſe be the ſame in the original and derivative vibrations. It remains therefore, that each ſimple idea of ſenſation be attended by diminutive vibrations of the ſame kind, place, and line of direction, with the original vibrations attending the ſenſation itſelf: or, in the words of the propoſition, that ſenſory vibrations, by being frequently repeated, beget a diſpoſition to diminutive vibrations correſponding to themſelves reſpectively. We may add, that the vibratory nature of the motion which attends ideas, may be inferred from the continuance of ſome ideas, viſible ones for inſtance, in the fancy for a few moments.

This proof of the preſent propoſition from the foregoing, appears to be inconteſtable, admitting the fourth: however, it will much eſtabliſh and illuſtrate the doctrines of vibrations and aſſociation, to deduce it directly, if we can, from the nature of vibratory motions, and of an animal body; and not only from the relation between ſenſations and ideas. Let us ſee, therefore, what progreſs we can make in ſuch an attempt.

Firſt, then, if we admit vibrations of the medullary particles at all, we muſt conceive, that ſome take place in the *fœtus in utero*, both on account of the warmth in which it lies, and of the pulſation of thoſe conſiderable arteries, which paſs through the medullary ſubſtance, and which conſequently muſt compreſs and agitate it upon every contraction of the heart. And theſe vibrations are probably either uniform in kind and degree, if we conſider ſhort ſpaces of time; or, if long ones, increaſe in a ſlow uniform manner, and that in degree only, as the *fœtus in utero* increaſes in bulk and ſtrength. They are alſo probably the ſame in all the different regions of the medullary ſubſtance. Let theſe vibrations be called the *natural vibrations.*

Secondly, As ſoon as the child is born, external objects act upon it violently, and excite vibrations in the medullary ſubſtance, which differ from the natural ones, and from each other, in degree, kind, place, and line of direction. We may alſo conceive, that each region of the medullary ſubſtance has ſuch a texture as to receive, with the greateſt facility, the ſeveral ſpecific vibrations, which the objects correſponding reſpectively to theſe regions, *i. e.* to their nerves are moſt diſpoſed to excite. Let theſe vibrations be, for the preſent, called *preternatural ones*, in contradiſtinction to thoſe which we juſt now called *natural ones.*

Thirdly, Repreſenting now the natural vibrations by *N*, and the preternatural ones, from various objects, by *A*, *B*, *C*, &c. let us ſuppoſe the firſt object to impreſs the vibrations *A*, and then to be removed. It is evident from the nature of vibratory motions, that the medullary ſubſtance will not, immediately upon the removal of this object, return to its natural ſtate *N*, but will remain, for a ſhort ſpace of time, in the preternatural ſtate *A*, and paſs gradually from *A* to *N*. Suppoſe the ſame object to be impreſſed again and again, for a ſufficient number of times, and it ſeems to follow, that the medullary ſubſtance will be longer in paſſing from *A* to *N*, after the ſecond impreſſion, than after the firſt, after the third impreſſion than ſecond, &c. till, at laſt, it will not return to its natural original ſtate of vibrations *N* at all, but remain in the preternatural ſtate *A*, after the vibrations have fallen to a diminutive pitch, their kind and place, or chief ſeat, and their line of direction, continuing the ſame. This ſtate may therefore be fitly denoted by *a*, and being now in the place of the natural ſtate *N*, it will be kept up by the heat of the medullary ſubſtance, and the pulſation of its arteries. All this ſeems to follow from the above-mentioned diſpoſition of animal bodies to accommodate themſelves to, and continue in, almoſt any ſtate that is often impreſſed; which is evident from innumerable both common and medical obſervations, whatever be determined concerning the manner of explaining and accounting for theſe facts. For the alterations which habit, cuſtom, frequent impreſſion, &c. make in the ſmall conſtituent particles, can ſcarce be any thing beſides alterations of the diſtances, and mutual actions, of theſe particles; and theſe laſt alterations muſt alter the natural tendency to vibrate. We muſt, however, here reſume the ſuppoſition made in the laſt paragraph, viz. that the ſeveral regions of the brain have ſuch a texture as diſpoſes them to thoſe ſpecific vibrations, which are to be impreſſed by the proper objects in the events of life. And this will much facilitate and accelerate the tranſition of the ſtate *N* into *a*; ſince we are to ſuppoſe a prediſpoſition to the ſtate *A*, or *a*.

It will ſomewhat illuſtrate and confirm this reaſoning, to remark, that muſical ſtrings always accommodate themſelves to, and lean towards, the ſtate into which they were laſt put. Thus the tone of a muſical ſtring either riſes or falls upon altering its tenſion, according as the preceding tenſion was greater or leſs than its preſent tenſion. Now the ſmall component parts of a muſical ſtring muſt recede from, and approach to each other, *i. e.* muſt oſcillate lengthways, during every tranſverſe oſcillation of the ſtring. And this muſt ariſe from the mutual influences of the component particles tending to their laſt ſuperinduced ſtate. Let us ſuppoſe ſomething analogous to this to take place in the component molecules of the brain, the molecules of the molecules, &c. and it will follow, that *A* may over-power *N*, and *a* become the natural ſtate. Now, ſince the human body is compoſed of the ſame matter as the external world, it is reaſonable to expect, that its component particles ſhould be ſubjected to the ſame ſubtle laws. And the exquiſite ſtructure of animal bodies in ſo many other reſpects, makes it eaſier to conceive, that the organ of organs, viz. the medullary ſubſtance ſhould be endued with a proper ſubtle ultimate ſtructure, for the purpoſe of retaining a ſtate that is frequently impreſſed. One may gueſs alſo, that it is better ſuited to this purpoſe during its growth, *i. e.* in paſſing from infancy to adult age, than afterwards; as this would be very agreeable to the phænomena.

Fourthly, Suppoſe now the vibrations *A*, *B*, *C*, *D*, &c. belonging to each of the ſenſes, to be excited, and repeated in ſuch order and manner as uſually happens to the new-born infant upon its entrance into this new ſcene of things. It is evident, that theſe will have a greater power to over-rule the natural ſtate *N*, than the vibrations *A* from one ſingle object could have: for *A* affected only one region of the medullary ſubſtance primarily; whereas *A*, *B*, *C*, *D*, &

&c. affect all the regions primarily in their turn. It is evident alſo, that the ſecondary vibrations, or thoſe which are propagated from the region of the medullary ſubſtance primarily affected into the reſt, will be over-ruled, in great meaſure, in each region, by the primary vibrations peculiar to that region. Laſtly, It is evident, that of the vibrations which are excited in each region, no one can prevail over all the reſt, but each muſt leave an effect, in proportion to its ſtrength and frequency. We may conceive therefore, that each region of the medullary ſubſtance will have a tendency generated in it, to vibrate with vibrations of the ſame frequency (but weaker in degree) as thoſe which the ſeveral appropriated objects impreſs upon it reſpectively; and that diminutive vibrations reſembling them will riſe in ſucceſſion in each region. For each region may eaſily be conceived to lean ſometimes to the vibrations from one object, ſometimes to thoſe from another, according to the ſtrength, frequency, and novelty of the impreſſion, the then preſent diſpoſition of the nervous ſyſtem, aſſociation (of which in the two next propoſitions), and other ſuch-like cauſes. And for the ſame reaſon, as in every ſenſe the idea of ſome one object of that ſenſe muſt prevail over all the reſt, we may conclude, that ſometimes the ideas belonging to one ſenſe, ſometimes thoſe belonging to another, will prevail over the reſt.

Or thus: Some vibrations there muſt always be in the medullary ſubſtance, on account of its heat, and the pulſation of the arteries which paſs through it. Theſe cannot be the natural ones *N*, becauſe they will ſoon be over-ruled by the great force and variety of the impreſſions made on the new-born infant, which muſt alſo diſpoſe each region of the brain to lean to ſome or other of thoſe vibrations which are excited in it primarily. Hence we may conceive, that a very complex ſet of vibrations, ariſing from the mixture and combinations of degree, kind, place, and line of direction, exiſts always in the medullary ſubſtance, being kept up by its heat, and the pulſation of its arteries, when other cauſes are wanting, almoſt in the ſame manner as in a concert of muſic the air is agitated by vibrations of a very complex kind. But then, as in a concert, ſome one inſtrument generally ſtrikes the ear more than the reſt, ſo of the complex vibrations which exiſt in the medullary ſubſtance, ſome one part will prevail over the reſt, and preſent the correſponding idea to the mind. Some region muſt be diſpoſed, at each inſtant, to vibrate ſtronger than the reſt; and of the ſpecific vibrations which are generally impreſſed upon this region, ſome one will have a more favourable concurrence of circumſtances than the reſt, And thus it will follow, according to the terms of the propoſition, that ſenſory vibrations, by being ſufficiently repeated, will beget a diſpoſition to miniature vibrations correſponding to them reſpectively; or, uſing the appellations above-aſſumed, that *A*, *B*, *C*, &c. will beget *a*, *b*, *c*, &c.

If we allow the proof of this propoſition, thus deduced from the nature of vibratory motions, and of an animal body, the foregoing propoſition will follow from it, and hold equally in reſpect of the ſenſes of feeling, taſte, and ſmell, as of ſight and hearing. Or, in other words, if we allow, that original impreſſed vibratory motions leave a tendency to miniature ones of the ſame kind, place, and line of direction, it will follow, that ſenſations muſt beget ideas, and that not only in the ſenſes of ſight and hearing, where the ideas are ſufficiently vivid and diſtinct, but in the three others, ſince their ſenſations are alſo conveyed to the mind by means of vibratory motions. We may alſo, perhaps, diſcover hereafter, from the nature of vibratory motions, and of the human brain, compared with the circumſtances of life, why the ideas of one ſenſe are more vivid and diſtinct than thoſe of another.

PROP.

PROP. X.

Any Senſations A, B, C, *&c. by being aſſociated with one another a ſufficient Number of Times, get ſuch a Power over the correſponding Ideas* a, b, c, *&c. that any one of the Senſations* A, *when impreſſed alone, ſhall be able to excite in the Mind* b, c, *&c. the Ideas of the Reſt.*

Sensations may be ſaid to be aſſociated together, when their impreſſions are either made preciſely at the ſame inſtant of time, or in the contiguous ſucceſſive inſtants. We may therefore diſtinguiſh aſſociation into two ſorts, the ſynchronous, and the ſucceſſive.

The influence of aſſociation over our ideas, opinions and affections, is ſo great and obvious, as ſcarce to have eſcaped the notice of any writer who has treated of theſe, though the word *aſſociation*, in the particular ſenſe here affixed to it, was firſt brought into uſe by Mr. *Locke*. But all that has been delivered by the ancients and moderns, concerning the power of habit, cuſtom, example, education, authority, party-prejudice, the manner of learning the manual and liberal arts, &c. goes upon this doctrine as its foundation, and may be conſidered as the detail of it, in various circumſtances. I here begin with the ſimpleſt caſe, and ſhall proceed to more and more complex ones continually, till I have exhauſted what has occurred to me upon this ſubject.

This propoſition, or firſt and ſimpleſt caſe of aſſociation, is manifeſt from innumerable common obſervations. Thus the names, ſmells, taſtes, and tangible qualities of natural bodies, ſuggeſt their viſible appearances to the fancy, *i. e.* excite their viſible ideas; and, *vice verſâ*, their viſible appearances impreſſed on the eye raiſe up thoſe powers of reconnoitering

noitering their names, ſmells, taſtes, and tangible qualities, which may not improperly be called their ideas, as above noted; and in ſome caſes raiſe up ideas, which may be compared with viſible ones, in reſpect of vividneſs. All which is plainly owing to the aſſociation of the ſeveral ſenſible qualities of bodies with their names, and with each other. It is remarkable, however, as being agreeable to the ſuperior vividneſs of viſible and audible ideas before taken notice of, that the ſuggeſtion of the viſible appearance from the name, is the moſt ready of any other; and, next to this, that of the name from the viſible appearance; in which laſt caſe, the reality of the audible idea, when not evident to the fancy, may be inferred from the ready pronunciation of the name. For it will be ſhewn hereafter, that the audible idea is moſt commonly a previous requiſite to pronunciation. Other inſtances of the power of aſſociation may be taken from compound viſible and audible impreſſions. Thus the ſight of part of a large building ſuggeſts the idea of the reſt inſtantaneouſly; and the ſound of the words which begin a familiar ſentence, brings the remaining part to our memories in order, the aſſociation of the parts being ſynchronous in the firſt caſe, and ſucceſſive in the laſt.

It is to be obſerved, that, in ſucceſſive aſſociations, the power of raiſing the ideas is only exerted according to the order in which the aſſociation is made. Thus, if the impreſſions *A*, *B*, *C*, be always made in the order of the alphabet, *B* impreſſed alone will not raiſe *a*, but *c* only. Agreeably to which, it is eaſy to repeat familiar ſentences in the order in which they always occur, but impoſſible to do it readily in an inverted one. The reaſon of this is, that the compound idea, *c*, *b*, *a*, correſponds to the compound ſenſation *C*, *B*, *A*; and therefore requires the impreſſion of *C*, *B*, *A*, in the ſame manner as *a*, *b*, *c*, does that of *A*, *B*, *C*. This will, however, be more evident, when we come to conſider the aſſociations of vibratory motions, in the next propoſition.

It is alſo to be obſerved, that the power of aſſociation grows feebler, as the number either of ſynchronous or ſucceſſive impreſſions is increaſed, and does not extend, with due force, to more than a ſmall one, in the firſt and ſimpleſt caſes. But, in complex caſes, or the aſſociations of aſſociations, of which the memory, in its full extent, conſiſts, the powers of the mind, deducible from this ſource, will be found much greater than any perſon, upon his firſt entrance on theſe inquiries, could well imagine.

PROP. XI.

Any Vibrations, A, B, C, *&c. by being aſſociated together a ſufficient Number of Times, get ſuch a Power over* a, b, c, *&c. the correſponding miniature Vibrations, that any of the Vibrations* A, *when impreſſed alone, ſhall be able to excite* b, c, *&c. the Miniatures of the Reſt.*

THIS propoſition may be deduced from the foregoing, in the ſame manner as the ninth has been from the eighth.

But it ſeems alſo deducible from the nature of vibrations, and of an animal body. Let *A* and *B* be two vibrations, aſſociated ſynchronically. Now, it is evident, that the vibration *A* (for I will, in this propoſition, ſpeak of *A* and *B* in the ſingular number, for the ſake of greater clearneſs) will, by endeavouring to diffuſe itſelf into thoſe parts of the medullary ſubſtance which are affected primarily by the vibration *B*, in ſome meaſure modify and change *B*, ſo as to make *B* a little different from what it would be, if impreſſed alone. For the ſame reaſons the vibration *A* will be a little affected, even in its primary ſeat, by the endeavour of *B* to diffuſe itſelf all over the medullary ſubſtance. Suppoſe now the vibrations *A* and *B* to be impreſſed at the ſame inſtant, for a thouſand times; it follows, from the ninth propoſition, that they will firſt over-come the diſpoſition to the natural vibrations *N*, and then leave a tendency to themſelves, which will now occupy the place of the original natural tendency to vibrations. When therefore the vibration *A* is impreſſed alone, it cannot be entirely ſuch as the object would excite of itſelf, but muſt lean, even in its primary ſeat, to the modifications and changes induced by *B*, during their thouſand joint impreſſions; and therefore much more, in receding from this primary ſeat, will it lean that way; and when it comes to the ſeat of *B*, it will excite *B*'s miniature a little modified and changed by itſelf.

Or thus: when *A* is impreſſed alone, ſome vibration muſt take place in the primary ſeat of *B*, both on account of the heat and pulſation of the arteries, and becauſe *A* will endeavour to diffuſe itſelf over the whole medullary ſubſtance. This cannot be that part of the natural vibrations *N*, which belongs to this region, becauſe it is ſuppoſed to be overruled already. It cannot be that which *A* impreſſed alone would have propagated into this region, becauſe that has always hitherto been over-ruled, and converted into *B*; and therefore cannot have begotten a tendency to itſelf. It cannot be any full vivid vibration, ſuch as *B*, *C*, *D*, &c. belonging to this region, becauſe all full vibrations require the actual impreſſion of an object upon the correſponding external organ. And of miniature vibrations belonging to this region, ſuch as *b*, *c*, *d*, &c. it is evident, that *b* has the preference, ſince *A* leans to it a little, even in its own primary ſeat, more and more, in receding from this, and almoſt entirely, when it comes to the primary ſeat of *B*. For the ſame reaſons *B* impreſſed alone will excite *a*; and, in general,

neral, if *A*, *B*, *C*, &c. be vibrations ſynchronically impreſſed on different regions of the medullary ſubſtance, *A* impreſſed alone will, at laſt, excite *b*, *c*, &c. according to the propoſition.

If *A* and *B* be vibrations impreſſed ſucceſſively, then will the latter part of *A*, viz. that part which, according to the third and fourth propoſitions, remains, after the impreſſion of the object ceaſes, be modified and altered by *B*, at the ſame time that it will a little modify and alter it, till at laſt it be quite over-powered by it, and end in it. It follows therefore, by a like method of reaſoning, that the ſucceſſive impreſſion of *A* and *B*, ſufficiently repeated, will ſo alter the medullary ſubſtance, as that when *A* is impreſſed alone, its latter part ſhall not be ſuch as the ſole impreſſion of *A* requires, but lean towards *B*, and end in *b* at laſt. But *B* will not excite *a* in a retrograde order, ſince, by ſuppoſition, the latter part of *B* was not modified and altered by *A*, but by ſome other vibration, ſuch as *C* or *D*. And as *B*, by being followed by *C*, may at laſt raiſe *c*, ſo *b*, when raiſed by *A*, in the method here propoſed, may be alſo ſufficient to raiſe *c*, inaſmuch as the miniature *c* being a feeble motion, not ſtronger, perhaps, than the natural vibrations *N*, requires only to have its kind, place, and line of direction, determined by aſſociation, the heat and arterial pulſation conveying to it the requiſite degree of ſtrength. And thus *A* impreſſed alone, will raiſe *b*, *c*, &c. in ſucceſſive aſſociations, as well as in ſynchronous ones, according to the propoſition.

It ſeems alſo, that the influence of *A* may, in ſome degree, reach through *B* to *C*; ſo that *A* of itſelf may have ſome effect to raiſe *c*, as well as by means of *b*. However, it is evident, that this chain muſt break off, at laſt, in long ſucceſſions, and that ſooner or later, according to the number and vigour of the repeated impreſſions. The power of miniature vibrations to raiſe other miniatures may, perhaps, be made clearer to mathematicians, by hinting, that the efficacy of any vibration to raiſe any other, is not in the ſimple ratio of its vividneſs, but as ſome power thereof leſs than unity; for thus *b* may raiſe *c*, a weaker vibration than *b*, *c* may raiſe *d*, &c. with more facility than if the efficacy was in the ſimple ratio of the vividneſs, and yet ſo, that the ſeries ſhall break off at laſt.

If the ninth propoſition be allowed, we may prove this in ſomewhat a ſhorter and eaſier manner, as follows. Since the vibrations *A* and *B* are impreſſed together, they muſt, from the diffuſion neceſſary to vibratory motions, run into one vibration; and conſequently, after a number of impreſſions ſufficiently repeated, will leave a trace, or miniature, of themſelves, as one vibration, which will recur every now and then, from ſlight cauſes. Much rather, therefore, may the part *b* of the compound miniature $a+b$ recur, when the part *A* of the compound original vibration $A+B$ is impreſſed.

And as the ninth propoſition may be thus made to prove the preſent, ſo it ought to be acknowledged and remarked here, that, unleſs the ninth be allowed, the preſent cannot be proved, or that the power of aſſociation is founded upon, and neceſſarily requires, the previous power of forming ideas, and miniature vibrations. For ideas, and miniature vibrations, muſt firſt be generated, according to the eighth and ninth propoſitions, before they can be aſſociated, according to the tenth and this eleventh. But then (which is very remarkable) this power of forming ideas, and their correſponding miniature vibrations, does equally preſuppoſe the power of aſſociation. For ſince all ſenſations and vibrations are infinitely diviſible, in reſpect of time and place, they could not leave any traces or images of themſelves, *i. e.* any ideas, or miniature vibrations, unleſs their infiniteſimal parts did cohere together through joint impreſſion; *i. e.* aſſociation. Thus, to mention a groſs inſtance, we could have no proper idea of a horſe, unleſs the particular ideas of the head, neck, body, legs, and tail, peculiar to this animal, ſtuck to each other in the fancy, from frequent joint impreſſion. And, therefore, in dreams, where complex aſſociations are much weakened, and various parcels of viſible ideas, not joined in nature, ſtart up together in the fancy, contiguous to each other, we often ſee monſters, chimeras, and combinations, which have never been actually preſented.

Aſſociation ſeems alſo neceſſary to diſpoſe the medullary ſubſtance to this or that miniature vibration, in ſucceſſion, after the miniatures of a large number of original vibrations have been generated.

Nor does there ſeem to be any preciſe limit which can be ſet to this mutual dependence of the powers of generating miniatures, and of aſſociation upon each other: however, they may both take place together, as the heart and brain are ſuppoſed to do, or both depend upon one ſimple principle; for it ſeems impoſſible, that they ſhould imply one another, *ad infinitum.* There is no greater difficulty here than in many other caſes of mutual indefinite implication, known and allowed by all. Nay, one may almoſt deduce ſome preſumption in favour of the hypotheſis here produced, from this mutual indefinite implication of its parts, ſo agreeable to the tenor of nature in other things. And it is certainly a preſumption in its favour, that a leſs power of generating miniatures will be a foundation for a larger of aſſociation, and *vice verſâ*, till, at laſt, the whole ſuperſtructure of ideas and aſſociations obſervable in human life, may by proceeding upwards according to analyſis, and downwards according to ſyntheſis, be built upon as ſmall a foundation as we pleaſe. Thus we may obſerve, that neither does this eleventh propoſition neceſſarily require the ninth, in its full extent, nor *vice verſâ*, for their demonſtration. The leaſt miniatures, with the feebleſt coheſions of their parts, will, by degrees, run into larger, with ſtronger coheſions, from the ſame principles; nor are there any viſible limits to the influence and extent of theſe powers, ſuppoſing the natural faculties of the being under conſideration ſufficiently extended.

Let me add, that the generation of ſenſible ideas from ſenſations, and the power of raiſing them from aſſociation, when conſidered as faculties of the mind, are evident and unqueſtionable. Since therefore ſenſations are conveyed to the mind, by the efficiency of corporeal cauſes upon the medullary ſubſtance, as is acknowledged by all phyſiologiſts and phyſicians, it ſeems to me, that the powers of generating ideas, and raiſing them by aſſociation, muſt alſo ariſe from corporeal cauſes, and conſequently admit of an explication from the ſubtle influences of the ſmall parts of matter upon each other, as ſoon as theſe are ſufficiently underſtood, which is farther evinced from the manifeſt influences of material cauſes upon our ideas and aſſociations, taken notice of under the ſecond propoſition. And as a vibratory motion is more ſuitable to the nature of ſenſation than any other ſpecies of motion, ſo does it ſeem alſo more ſuitable to the powers of generating ideas, and raiſing them by aſſociation. However, theſe powers are evident independently, as juſt now obſerved; ſo that the doctrine of aſſociation may be laid down as a certain foundation, and a clue to direct our future inquiries, whatever becomes of that of vibrations.

PROP. XII.

Simple Ideas will run into complex ones, by Means of Aſſociation.

In order to explain and prove this propoſition, it will be requiſite to give ſome previous account of the manner in which ſimple ideas of ſenſation may be aſſociated together.

Caſe 1. Let the ſenſation *A* be often aſſociated with each of the ſenſations *B*, *C*, *D*, &c. *i. e.* at certain times with *B*, at certain other times with *C*, &c. it is evident, from the tenth propoſition, that *A*, impreſſed alone, will, at laſt, raiſe *b*, *c*, *d*, &c. all together *i. e.* aſſociate them with one another, provided they belong to different regions of the medullary ſubſtance; for if any two, or more, belong to the ſame region, ſince they cannot exiſt together in their diſtinct forms, *A* will raiſe ſomething intermediate between them.

Caſe 2. If the ſenſations *A*, *B*, *C*, *D*, &c. be aſſociated together, according to various combinations of twos, or even threes, fours, &c. then will *A* raiſe *b*, *c*, *d*, &c. alſo *B* raiſe *a*, *c*, *d*, &c. as in caſe the firſt.

It may happen, indeed, in both caſes, that *A* may raiſe a particular miniature, as *b*, preferably to any of the reſt, from its being more aſſociated with *B*, from the novelty of the impreſſion of *B*, from a tendency in the medullary ſubſtance to favour *b*, &c. and, in like manner, that *b* may raiſe *c* or *d* preferably to the reſt. However, all this will be over-ruled, at laſt, by the recurrency of the aſſociations; ſo that any one of the ſenſations will excite the ideas of the reſt, at the ſame inſtant, *i. e.* aſſociate them together.

Caſe 3. Let *A*, *B*, *C*, *D*, &c. repreſent ſucceſſive impreſſions, it follows from the tenth and eleventh propoſitions, that *A* will raiſe *b*, *c*, *d*, &c. *B* raiſe *c*, *d*, &c. And though the ideas do not, in this caſe, riſe preciſely at the ſame inſtant, yet they come nearer together than the ſenſations themſelves did in their original impreſſion; ſo that theſe ideas are aſſociated almoſt ſynchronically at laſt, and ſucceſſively from the firſt. The ideas come nearer to one another than the ſenſations, on account of their diminutive nature, by which all that appertains to them is contracted. And this ſeems to be as agreeable to obſervation as to theory.

Caſe 4. All compound impreſſions $A+B+C+D$, &c. after ſufficient repetition leave compound miniatures $a+b+c+d$, &c. which recur every now and then from ſlight cauſes, as well ſuch as depend on aſſociation, as ſome which are different from it. Now, in theſe recurrencies of compound miniatures, the parts are farther aſſociated, and approach perpetually nearer to each other, agreeably to what was juſt now obſerved; *i. e.* the aſſociation becomes perpetually more cloſe and intimate.

Caſe 5. When the ideas *a*, *b*, *c*, *d*, &c. have been ſufficiently aſſociated in any one or more of the foregoing ways, if we ſuppoſe any ſingle idea of theſe, *a* for inſtance, to be raiſed by the tendency of the medullary ſubſtance that way, by the aſſociation of *A* with a foreign ſenſation or idea *X* or *x*, &c. this idea *a*, thus raiſed, will frequently bring in all the reſt, *b*, *c*, *d*, &c. and ſo aſſociate all of them together ſtill farther.

And, upon the whole, it may appear to the reader, that the ſimple ideas of ſenſation muſt run into cluſters and combinations, by aſſociation; and that each of theſe will, at laſt, coaleſce into one complex idea, by the approach and commixture of the ſeveral compounding parts.

It appears alſo from obſervation, that many of our intellectual ideas, ſuch as thoſe that belong to the heads of beauty, honour, moral qualities, &c. are, in fact, thus compoſed of parts, which, by degrees, coaleſce into one complex idea.

And as this coaleſcence of ſimple ideas into complex ones is thus evinced, both by the foregoing theory, and by obſervation, ſo it may be illuſtrated, and farther confirmed, by the ſimilar coaleſcence of letters into ſyllables and words, in which aſſociation is likewiſe a chief inſtrument. I ſhall mention ſome of the moſt remarkable particulars, relating to this coaleſcence of ſimple ideas into complex ones, in the following corollaries.

Cor. 1. If the number of ſimple ideas which compoſe the complex one be very great, it may happen, that the complex idea ſhall not appear to bear any relation to theſe its compounding parts, nor to the external ſenſes upon which the original ſenſations, which gave birth to the compounding ideas, were impreſſed. The reaſon of this is, that each ſingle idea is over-powered by the ſum of all the reſt, as ſoon as they are all intimately united together. Thus, in very compound medicines, the ſeveral taſtes and flavours of the ſeparate ingredients are loſt and over-powered by the complex one of the whole maſs: ſo that this has a taſte and flavour of its own, which appears to be ſimple and original, and like that of a natural body. Thus alſo, white is vulgarly thought to be the ſimpleſt and moſt uncompounded of all colours, while yet it really ariſes from a certain proportion of the ſeven primary colours, with their ſeveral ſhades, or degrees. And, to reſume the illuſtration above-mentioned, taken from language, it does not at all appear to perſons ignorant of the arts of reading and writing, that the great variety of complex words of languages can be analyſed up to a few ſimple ſounds.

Cor. 2. One may hope, therefore, that, by purſuing and perfecting the doctrine of aſſociation, we may ſome time or other be enabled to analyſe all that vaſt variety of complex ideas, which paſs under the name of ideas of reflection, and intellectual ideas, into their ſimple compounding parts, *i. e.* into the ſimple ideas of ſenſation, of which they conſiſt. This would be greatly analogous to the arts of writing, and reſolving the colours of the ſun's light, or natural bodies, into their primary conſtituent ones. The complex ideas which I here ſpeak of, are generally excited by words, or viſible objects; but they are alſo connected with other external impreſſions, and depend upon them, as upon ſymbols. In whatever way we conſider them, the trains of them which are preſented to the mind ſeem to depend upon the then preſent ſtate of the body, the external impreſſions and the remaining influence of prior impreſſions and aſſociations, taken together.

Cor. 3. It would afford great light and clearneſs to the art of logic, thus to determine the preciſe nature and compoſition of the ideas affixed to thoſe words which have complex ideas, in a proper ſenſe, *i. e.* which excite any combinations of ſimple ideas united intimately by aſſociation; alſo to explain, upon this foundation, the proper uſe of thoſe words, which have no ideas. For there are many words which are mere ſubſtitutes for other words, and many which are only auxiliaries. Now it cannot be ſaid, that either of theſe have ideas, properly ſo called. And though it may ſeem an infinite and impoſſible taſk, thus to analyſe the ſignifications and uſes of words, yet, I ſuppoſe, this would not be more difficult, with the preſent philological and philoſophical helps to ſuch a work, than the firſt making of dictionaries and grammars, in the infancy of philology. Perhaps it may not be amiſs juſt to hint, in this place, that the four following claſſes compriſe all the poſſible kinds into which words can be diſtinguiſhed, agreeably to the plan here propoſed:

1. Words which have ideas, but no definitions.
2. Words which have both ideas and definitions.
3. Words which have definitions, but no ideas.
4. Words which have neither ideas nor definitions.

It is quite manifeſt, that words ſeen or heard, can raiſe no ideas in the mind, or vibrations in the brain, diſtinct from their viſible and audible impreſſions, except as far as they get new powers from aſſociations, either incidental ones, or ariſing from expreſs deſign, as in definitions; and therefore, that all other ways of conſidering words, beſides what is here ſuggeſted, are either falſe or imperfect.

Cor. 4. As ſimple ideas run into complex ones by aſſociation, ſo complex ideas run into decomplex ones by the ſame. But here the varieties of the aſſociations, which increaſe with the complexity, hinder particular ones from being ſo cloſe and permanent, between the complex parts of decomplex ideas, as between the ſimple parts of complex ones: to which it is analogous, in languages, that the letters of words adhere cloſer together than the words of ſentences, both in writing and ſpeaking.

(i.e.) collec-
tions of
complex

Cor. 5. The ſimple ideas of ſenſation are not all equally and uniformly concerned in forming complex and decomplex ideas, *i. e.* theſe do not reſult from all the poſſible combinations of twos, threes, fours, &c. of all the ſimple ideas; but, on the contrary, ſome ſimple ideas occur in the complex and decomplex ones much oftener than others: and the ſame holds of particular combinations by twos, threes, &c. and innumerable combinations never occur at all in real life, and conſequently are never aſſociated into complex or decomplex ideas. All which correſponds to what happens in real languages; ſome letters, and combinations of letters, occur much more frequently than others, and ſome combinations never occur at all.

Cor. 6. As perſons who ſpeak the ſame language have, however, a different uſe and extent of words, ſo, though mankind, in all ages and nations, agree, in general, in their complex and decomplex ideas, yet there are many particular differences in them; and theſe differences are greater or leſs, according to the difference, or reſemblance, in age, conſtitution, education, profeſſion, country, age of the world, &c. *i. e.* in their impreſſions and aſſociations.

Cor. 7. When a variety of ideas are aſſociated together, the viſible idea, being more glaring and diſtinct than the reſt, performs the office of a ſymbol to all the reſt, ſuggeſts them, and connects them together. In this it ſomewhat reſembles the firſt letter of a word, or firſt word of a ſentence, which are often made uſe of to bring all the reſt to mind.

Cor. 8. When objects and ideas, with their moſt common combinations, have been often preſented to the mind, a train of them, of a conſiderable length, may, by once occurring, leave ſuch a trace, as to recur in imagination, and in miniature, in nearly the ſame order and proportion as in this ſingle occurrence. For ſince each of the particular impreſſions and ideas is familiar, there will want little more for their recurrency, than a few connecting links; and even theſe may be, in ſome meaſure, ſupplied by former ſimilar inſtances. Theſe conſiderations, when duly unfolded, ſeem to me ſufficient to explain the chief phænomena of memory; and it will be eaſily ſeen from them, that the memory of adults, and maſters in any ſcience, ought to be much more ready and certain than that of children and novices, as it is found to be in fact.

Cor. 9. When the pleaſure or pain attending any ſenſations, and ideas, is great, all the aſſociations belonging to them are much accelerated and ſtrengthened. For the violent vibrations excited in ſuch caſes, ſoon over-rule the natural vibrations, and leave in the brain a ſtrong tendency to themſelves, from a few impreſſions. The aſſociations will therefore be cemented ſooner and ſtronger than in common caſes; which is found agreeable to the fact.

Cor. 10. As many words have complex ideas annexed to them, ſo ſentences, which are collections of words, have collections of complex ideas, *i. e.* have decomplex ideas. And it happens, in moſt caſes, that the decomplex idea belonging to any ſentence, is not compounded merely of the complex ideas belonging to the words of it; but that there are alſo many variations, ſome oppoſitions, and numberleſs additions. Thus propoſitions, in particular, excite, as ſoon as heard, aſſent or diſſent; which aſſent and diſſent conſiſt chiefly of additional complex ideas, not included in the terms of the propoſition. And it would be of the greateſt uſe, both in the ſciences and in common life, thoroughly to analyſe this matter, to ſhew in what manner, and by what ſteps, *i. e.* by what impreſſions and aſſociations, our aſſent and diſſent, both in ſcientifical and moral ſubjects, is formed.

PROP. XIII.

When ſimple Ideas run into a complex one, according to the foregoing Propoſition, we are to ſuppoſe, that the ſimple miniature Vibrations correſponding to thoſe ſimple Ideas run, in like Manner, into a complex miniature Vibration, correſponding to the reſulting complex Idea.

This propoſition is analogous to the ninth and eleventh, and may be deduced from the laſt, as they are from the eighth and tenth reſpectively. It is alſo an evidence and illuſtration of the ſecond, ſhewing not only, that the ſtate of the medullary ſubſtance is changed, according to the ſeveral natures of the ideas which are preſented to the mind; but alſo ſhewing, in general, of what kind this change is, and in what manner it is effected.

PROP. XIV.

It is reaſonable to think, that ſome of the complex Vibrations attending upon complex Ideas, according to the laſt Propoſition, may be as vivid, as any of the ſenſory Vibrations excited by the direct Action of Objects.

For theſe complex vibrations may conſiſt of ſo many parts co-exiſtent and ſucceſſive, and theſe parts may ſo alter and exalt one another, as that the reſulting agitations in the medullary ſubſtance may no longer be miniature vibrations, but vivid ones, equal to thoſe excited by objects impreſſed on the ſenſes. This proceſs may be farther favoured by a mixture of vivid real impreſſions among the ideas, by the irritability of the medullary ſubſtance, by a previous diſpoſition to the vibrations to be excited, &c.

Cor. 1. When the complex miniature vibrations are thus exalted in degree, we are to conceive, that the correſponding complex ideas are proportionally exalted, and ſo paſs into intellectual affections and paſſions. We are therefore to deduce the origin of the intellectual pleaſures and pains, which are the objects of theſe affections and paſſions, from the ſource here laid open.

Cor. 2. Since the preſent propoſition unfolds the nature of the affections and will, in the ſame manner, and from the ſame principles, as the twelfth does that of ideas, intellect, memory, and fancy, it follows, that all theſe are of the ſame original and conſideration, and differ only in degree, or ſome accidental circumſtances. They are all deducible from the external impreſſions made upon the ſenſes, the veſtiges or ideas of theſe, and their mutual connections by means of aſſociation, taken together and operating on one another.

Cor. 3. It follows alſo from this propoſition, that the intellectual pleaſures and pains may be greater, equal, or leſs, than the ſenſible ones, according as each perſon unites more or fewer, more vivid or more languid miniature vibrations, in the formation of his intellectual pleaſures and pains, &c.

Cor. 4. It is evident, that all the vibrations which belong to ideas, and intellectual affections, muſt reſide in the brain, or even in the moſt internal parts of it, not in the ſpinal marrow, or nerves. The brain is therefore the ſeat of the rational ſoul, *i. e.* of the ſoul, as far as it is influenced by reaſons and moral motives, even though we ſhould admit, that the ſpinal marrow and nerves are, in part, the ſenſorium, or the ſeat of the ſenſitive ſoul; which is ſome argument, that this ought not to be admitted, but that the ſenſorium, in men at leaſt, ought to be placed in the internal parts of the brain.

Cor. 5. It is of the utmoſt conſequence to morality and religion, that the affections and paſſions ſhould be analyſed into their ſimple compounding parts, by reverſing the ſteps of the aſſociations which concur to form them. For thus we may learn how to cheriſh and improve good ones, check and root out ſuch as are miſchievous and immoral, and how to ſuit our manner of life, in ſome tolerable meaſure, to our intellectual and religious wants. And as this holds, in reſpect of perſons of all ages, ſo it is particularly true, and worthy of conſideration, in reſpect of children and youth. The world is, indeed, ſufficiently ſtocked with general precepts for this purpoſe, grounded on experience; and whoſoever will follow theſe faithfully, may expect good general ſucceſs. However, the doctrine of aſſociation, when traced up to the firſt rudiments of underſtanding and affection, unfolds ſuch a ſcene as cannot fail both to inſtruct and alarm all ſuch as have any degree of intereſted concern for themſelves, or of a benevolent one for others. It ought to be added here, that the doctrine of aſſociation explains alſo the riſe and progreſs of thoſe voluntary and ſemivoluntary powers, which we exert over our ideas, affections, and bodily motions (as I ſhall ſhew hereafter, *prop.* 21.); and, by doing this, teaches us how to regulate and improve theſe powers.

Cor. 6. If beings of the ſame nature, but whoſe affections and paſſions are, at preſent, in different proportions to each other, be expoſed for an indefinite time to the ſame impreſſions and aſſociations, all their particular differences will, at laſt, be over-ruled, and they will become perfectly ſimilar, or even equal. They may alſo be made perfectly ſimilar, in a finite time, by a proper adjuſtment of the impreſſions and aſſociations.

Cor. 7. Our original bodily make, and the impreſſions and aſſociations which affect us in paſſing through life, are ſo much alike, and yet not the ſame, that there muſt be both a great general reſemblance amongſt mankind, in reſpect of their intellectual affections, and alſo many particular differences.

Cor. 8. Some degree of ſpirituality is the neceſſary conſequence of paſſing through life. The ſenſible pleaſures and pains muſt be transferred by aſſociation more and more every day, upon things that afford neither ſenſible pleaſure nor ſenſible pain in themſelves, and ſo beget the intellectual pleaſures and pains.

Cor. 9. Let the letters *a*, *b*, *c*, *d*, *e*, &c. repreſent the ſenſible pleaſures; *x*, *y*, and *z*, the ſenſible pains, ſuppoſed to be only three in number; and let us ſuppoſe all theſe, both pleaſures and pains, to be equal to one another: if now the ideas of theſe ſenſible pleaſures and pains be aſſociated together, according to all the poſſible varieties, in order to form intellectual pleaſures and pains, it is plain, that pleaſure muſt prevail in all the combinations of ſeven or more letters; and alſo, that when the ſeveral parts of theſe complex pleaſures are ſufficiently united by aſſociation, the pains which enter their compoſition will no longer be diſtinguiſhed ſeparately, but the reſulting mixed and complex pleaſures appear to be pure and ſimple ones, equal in quantity to the exceſs of pleaſure above pain, in each combination. Thus aſſociation would convert a ſtate, in which pleaſure and pain were both perceived by turns, into one in which pure pleaſure alone would be perceived; at leaſt, would cauſe the beings who were under its influence to an indefinite degree, to approach to this laſt ſtate nearer than by any definite difference. Or, in other words, aſſociation, under the ſuppoſition of this corollary, has a tendency to reduce the ſtate of thoſe who have eaten of the tree of the knowledge of good and evil, back again to a paradiſiacal one. Now, though the circumſtances of mankind are not the ſame with thoſe ſuppoſed in this corollary, yet they bear a remarkable reſemblance thereto, during that part of our exiſtence which is expoſed to our obſervation. For our ſenſible pleaſures are far more numerous than our ſenſible pains; and though the pains be, in general, greater than the pleaſures, yet the ſum total of theſe ſeems to be greater than that of thoſe; whence the remainder, after the deſtruction of the pains by the oppoſite and equal pleaſures, will be pure pleaſure.

Cor. 10. The intellectual pleaſures and pains are as real as the ſenſible ones, being, as we have ſeen, nothing but the ſenſible ones variouſly mixed and compounded together. The intellectual pleaſures and pains are alſo all equally of a factitious and acquired nature. We muſt therefore eſtimate all our pleaſures equally, by their magnitude, permanency, and tendency to procure others; and our pains in like manner.

Cor. 11. The ſenſible pleaſures and pains have a greater tendency to deſtroy the body, than the intellectual ones; for they are of a particular local nature, and ſo bear hard upon the organs which convey them. But the deſtruction of any one conſiderable part of the body is the deſtruction of the whole, from the ſympathy of the parts; whereas the intellectual pleaſures and pains, being collected from all quarters, do not much injure any organ particularly, but rather bring on an equable gradual decay of the whole medullary ſubſtance, and all the parts thereon depending.

Cor. 12. This propoſition, and its corollaries, afford ſome pleaſing preſumptions; ſuch are, that we have a power of ſuiting our frame of mind to our circumſtances, of correcting what is amiſs, and improving what is right: that our ultimate happineſs appears to be of a ſpiritual, not corporeal nature; and therefore that death, or the ſhaking off the groſs body, may not ſtop our progreſs, but rather render us more expedite in the purſuit of our true end: that aſſociation tends to make us all ultimately ſimilar; ſo that if one be happy, all muſt: and, laſtly, that the ſame aſſociation may alſo be ſhewn to contribute to introduce pure ultimate ſpiritual happineſs, in all, by a direct argument, as well as by the juſt mentioned indirect one.

SECT. III.

OF MUSCULAR MOTION, AND ITS TWO KINDS, AUTOMATIC AND VOLUNTARY; AND OF THE USE OF THE DOCTRINES OF VIBRATIONS AND ASSOCIATION, FOR EXPLAINING THESE RESPECTIVELY.

PROP. XV.

It is probable, that muſcular Motion is performed in the ſame general Manner as Senſation, and the Perception of Ideas.

For, firſt, ſenſation, the perception of ideas, and a locomotive faculty, *i. e.* muſcular motion, are the three moſt eminent marks of diſtinction between the animal and vegetable world: therefore ſince it is already found, that the two firſt are performed by the ſame means, *i. e.* vibrations, there is ſome preſumption, that the laſt will not require a different one.

Secondly, Of the two ſorts of motion, viz. automatic and voluntary, the firſt depends upon ſenſation, the laſt upon ideas, as I ſhall ſhew particularly hereafter, and may appear, in general, to any one, upon a ſlight attention; whence it follows, that ſenſation, and automatic motion, muſt be performed in the ſame general manner, alſo the perception of ideas, and voluntary motion: and therefore, ſince ſenſation and perception, the two antecedents, agree in their cauſes, automatic and voluntary motion, the two conſequents, *i. e.* all the four, muſt likewiſe.

Thirdly, It appears from the firſt and ſecond propoſitions, that the white medullary ſubſtance is the common inſtrument of ſenſation, ideas, and motion; and by the fifth, that this ſubſtance is uniform and continuous every where. Hence it follows, that the ſubtle motions excited in the ſenſory nerves, and medullary ſubſtance of the brain, during ſenſation and intellectual perception, muſt, of whatever kind they be, paſs into the motory nerves; and when they are arrived there, it is probable, that they muſt cauſe the contraction of the muſcles, both becauſe otherwiſe their arrival at the motory nerves would be ſuperfluous, and becauſe ſome ſuch ſubtle motions are required for this purpoſe.

Cor. 1. All arguments therefore which prove the performance of ſenſation and intellectual perception, by means of vibrations of the ſmall medullary particles, muſt infer, that muſcular motion is performed by vibrations alſo. And converſely, if vibrations can be ſhewn to take place in muſcular motion, they muſt alſo be inſtrumental in ſenſation and intellectual perception.

Cor. 2. There are certain experiments and obſervations which favour the ſuppoſition of the performance of muſcular motion by ſubtle agitations in the ſmall particles of the muſcular fibres, *i. e.* by vibratory motions. It follows therefore, that theſe experiments and obſervations are ſome additional evidence for the exiſtence of ſenſory and ideal vibrations, as above explained. Such are, that the motion of the heart, and of other muſcles, may be renewed in dying animals, and thoſe that are newly dead, by heat, injection of a fluid, and punctures, it being eaſy to be conceived, that the two laſt cauſes ſhould put the particles of the fibres into agitations for a ſhort time, *i. e.* till they can recover their equilibrium, by altering their diſtances, and mutual actions: and the firſt cauſe, *i. e.* heat, is, by the common conſent of all, judged to conſiſt in, and to cauſe, ſubtle vibratory motions. It is alſo difficult to aſſign any other action which theſe cauſes can have. In like manner the alternate contractions and relaxations of the hearts of frogs, vipers, and ſome other animals, which continue for long ſpaces of time after theſe have been entirely ſeparated from their bodies, ſeem utterly inexplicable upon any of the common ſuppoſitions, but follow eaſily from the doctrine of vibrations, as it is applied to muſcular motion, in the two next propoſitions.

Cor. 3. Since the ſame motion which occaſions ſenſation, and intellectual perception, paſſes through the ſeats of theſe into the motory nerves, in order to excite there the automatic and voluntary motions, thus pervading the whole medullary ſubſtance, in various ways, according to the variety of the circumſtances, but in all with the greateſt preciſion and exactneſs, it follows, that this muſt be a vibratory one, and that of the moſt ſubtle kind. For the ſame exceſs of ſoftneſs, which renders the medullary ſubſtance totally inelaſtic as to ſenſe, and conſequently unfit for the groſſer vibrations of the particles of the firſt or largeſt order (by the vibrations of which, in ſonorous bodies, it ſeems, that ſound is excited in the air), may render it more ſuſceptible of vibrations, in the particles of the ſecond, third, &c. orders; and if we ſuppoſe a proper ultimate ſtructure in the ſeveral parts of the medullary ſubſtance, theſe vibrations may be conveyed with all that preciſion and variety which the phænomena require. And, unleſs we do ſuppoſe ſome ſuch ſubtle vibrations as theſe, it will be extremely difficult to conceive, how ſo ſoft a pulp as the medullary ſubſtance is, ſhould be the common inſtrument of ſenſation, thought, and motion; which yet all phyſicians and philoſophers muſt allow, according to the firſt and ſecond propoſitions. If we ſet aſide ſubtle vibratory motions, the impulſe of the objects of ſenſe can communicate nothing, as it ſeems, to ſo ſoft a ſubſtance, but an uniform preſſure, ſuſceptible of few or no modifications, and conſequently highly unſuitable to the great variety of the phænomena that are to be ſolved by it. This argument therefore tends to ſhew, that ſenſation, thought, and motion, muſt all be performed by vibrations.

PROP. XVI.

The Phænomena of muſcular Contraction appear to be ſufficiently agreeable to the Doctrine of Vibrations.

In order to ſhew this, let us make the following ſuppoſitions:

Firſt, That vibrations deſcend along the motory nerves, *i. e.* the nerves which go to the muſcles, in ſome ſuch manner as ſound runs along the ſurfaces of rivers, or an electrical virtue along hempen ſtrings.

Secondly, That theſe vibrations, when they arrive at the muſcular fibres, are communicated to them, ſo that the ſmall particles of theſe fibres ſhall be agitated with like vibrations.

Thirdly, That the vibrations thus excited in the fibres, put into action an attractive virtue, perhaps of the electrical kind, which lies concealed in the particles of the fibres, or in the blood globules, or both. That the blood globules of animals are electrical, may be conjectured from the electricity of thoſe of the muſcle-ſhell fiſh, obſerved by Dr. *Hales*; and that the red blood has a principal ſhare in muſcular contraction, is highly probable, from the red colour of all the great muſcles of the body, and from the weakneſs of all young animals, and of ſuch as want a due ſhare of red blood. At the ſame time, it appears from exanguious and tranſparent animals, that pale fibres, and colourleſs fluids, have all the neceſſary requiſites for muſcular contraction, in certain degrees.

Fourthly, We muſt now ſuppoſe, in conſequence of the three foregoing ſuppoſitions, that each muſcular fibre, and conſequently the whole muſcle, is made ſhorter by this increaſe of attraction in its particles; whilſt yet their approach to each other is ſo ſmall, as that the whole bulk of the muſcle is but little diminiſhed; for though the length of the muſcle is leſſened, its other dimenſions are increaſed.

Fifthly, If we ſuppoſe the ſmall ultimate fibres of the muſcles to bend alternately to the right and left, as an eel does, at exceedingly ſhort intervals, agreeably to Dr. *Lower*, this may ſomewhat aſſiſt us to conceive in what manner a muſcle may be ſhortened, and yet ſo increaſed in breadth and thickneſs, as to remain of nearly the ſame dimenſions. For if theſe flexures be increaſed by the increaſe of the attraction of the parts, the whole muſcle will become ſhorter and thicker, as it is found to be in contraction; and converſely when the flexures are drawn out, the muſcle will be longer and thinner, *i. e.* in a ſtate of relaxation. The ſmall wrinkles which have been obſerved in the muſcular fibres, by *Leeuwenhoek*, and others, the wavings and curls which frequently appear to the eye in muſcles, after boiling or roaſting, and the rhomboidal pinnulæ taken notice of by Dr. *Hales* in the abdominal muſcles of a living frog, when under contraction, all ſeem to favour this fifth ſuppoſition.

Dr. *Pemberton* conjectures, that the cauſe of the contraction of muſcular fibres is no other than the common cauſe of the coheſion of the ſmall particles of the muſcular fibres increaſed. And this ſeems very probable; for the muſcles are hard during contraction, ſoft during relaxation; and hardneſs and ſoftneſs are evidently nothing but variations in the coheſion of the ſmall particles of bodies. Neither is this conjecture at all repugnant to the ſuppoſition of an electrical attraction above made, or to the doctrine of vibrations; for electricity may reach to ſmall diſtances, without being excited by friction, and flow from the ſame principle as the coheſion of bodies, as Sir *Iſaac Newton* has obſerved. It may therefore be the general cauſe of coheſion, and may be excited in the muſcular fibres in an extraordinary degree, whenever extraordinary vibrations are communicated to them. Or, if we ſuppoſe the cauſe of coheſion to be ſomething diſtinct from electricity, it may, however, be increaſed by vibrations of the ſmall cohering particles.

PROP. XVII.

That Propenſity to alternate Contraction and Relaxation, which is obſerved in almoſt all the Muſcles of the Body, admits of a Solution from the Doctrine of Vibrations.

For, when the fibres are in a ſtate of contraction, they are hard; and this hardneſs, if it be ſuppoſed to extend to the ſmall particles (which is no unreaſonable ſuppoſition), muſt render the particles of theſe particles, *i. e.* the particles ſuppoſed in theſe propoſitions to be agitated with vibrations, indiſpoſed to receive theſe vibrations; but the free admiſſion of theſe vibrations is by ſuppoſition the cauſe which excites the attractions of the particles, and the conſequent contraction of the muſcle. It follows therefore, that the hardneſs which impedes theſe vibrations, muſt alſo leſſen the attraction and contraction; or, in other words, that the contraction of a muſcle, when carried to a certain degree, muſt check itſelf, and bring on a relaxation, after a time ſufficient for the proper cauſes to take effect.

In like manner, when a muſcle is relaxed, the vibrations which deſcend along the motory nerves, paſs freely into the muſcular fibres, increaſe the attractions of the particles, and bring on the oppoſite ſtate, that of contraction; and ſo on alternately.

The fibres of the relaxed muſcle may alſo be conſidered as under a ſtate of diſtention to a certain degree, and conſequently as liable to an increaſe of vibrations upon this account. To which we may farther add, that ſince vibrations are hindered from paſſing into the contracted muſcle, in the manner juſt now explained, they will paſs with greater force into the relaxed one, from the place of the common derivation of their nerves, wherever there are antagoniſt muſcles that derive nerves from the ſame trunk, as in the limbs, and muſcles of reſpiration.

Cor. It appears from this method of conſidering the contractions and relaxations of muſcles, that there is a certain degree of hardneſs or contraction in muſcular fibres, which may be ſuppoſed juſt to balance each degree of force with which vibrations deſcend into the muſcular fibres; and that, while this equilibrium ſubſiſts, the contraction can neither be increaſed nor abated.

PROP. XVIII.

The Vibrations, of which an Account has been given in this Chapter, may be ſuppoſed to afford a ſufficient Supply of motory Vibrations, for the Purpoſe of contracting the Muſcles.

In order to make this appear, it will be proper to diſtinguiſh the motory vibrations, or thoſe which deſcend along the nerves of the muſcles into their fibres, into the five following claſſes:

Firſt then, we are to conceive, that thoſe ſenſory vibrations which are excited in the external organs, and aſcend towards the brain, when they arrive, in their aſcent, at the origins of motory nerves, as they ariſe from the ſame common trunk, plexus, or ganglion,

glion, with the ſenſory ones affected, detach a part of themſelves at each of theſe origins down the motory nerves; which part, by agitating the ſmall particles of the muſcular fibres, in the manner explained in the ſixteenth propoſition, excites them to contraction.

Secondly, The remainder of the ſenſory vibrations, which arrives at the brain, not being detached down the motory nerves in its aſcent thither, muſt be diffuſed over the whole medullary ſubſtance. It will therefore deſcend from the brain into the whole ſyſtem of motory nerves, and excite ſome feeble vibrations, at leaſt, in them. The ſame may be obſerved of ideal vibrations generated in the brain by aſſociation; theſe muſt pervade the whole medullary ſubſtance, and conſequently affect all the motory nerves in ſome degree.

Thirdly, The heat of the blood, and pulſation of the arteries, which paſs through the medullary ſubſtance, muſt always excite, or keep up, ſome vibrations in it; and theſe muſt always deſcend into the whole ſyſtem of muſcles. And I apprehend, that from theſe two laſt ſources, taken together, we may account for that moderate degree of contraction, or tendency thereto, which is obſervable in all the muſcles, at leaſt in all thoſe of healthy adults, during vigilance.

Fourthly, When vivid vibrations are excited in membranes of an uniform texture, by a ſtimulus of any kind, they ſeem to run over the whole extent of ſuch membranes, and by this means to have a great influence in contracting all the muſcles that lie near any part of this membrane, though they be remote from the place of the ſtimulus. The manner in which this is effected, I conceive to be as follows: the repeated or continued action of the ſtimulus diffuſes vibrations from the place of its action over the whole membrane, which, by their reciprocal influences, become

come equal, or nearly ſo, in every part of it, and are, at laſt, ſo exalted, as to contract every part. As ſoon as this contraction takes place, the vibrations in its ſmall particles muſt ceaſe for reaſons given above. They will therefore be propagated almoſt inſtantaneouſly over the neighbouring muſcles, from the nervous communications between the membrane and the neighbouring muſcles; by which all changes made in the nerves of the membrane muſt affect thoſe of the neighbouring muſcles. As therefore during the vivid vibrations of the particles of the membrane, we muſt ſuppoſe ſome to be propagated into the neighbouring muſcles, agreeably to the firſt article of this propoſition, ſo, upon their ſudden ceſſation, ſuch a change may reaſonably be ſuppoſed, in the communicating nervous fibrils, as ſhall agitate the æther contained in them with much more vivid vibrations than before; and theſe vibrations muſt now paſs into the muſcles alone, ſince the contraction of the membrane hinders them from returning into it. I ſhall hereafter produce ſeveral examples of this proceſs, in detail. It may ſuffice, at preſent, juſt to mention the action of ſneezing, and to deſire the reader to compare this action, in a curſory way, with the foregoing account.

Fifthly, I have, in the laſt article, ſhewn how a ceſſation of vibrations in the particles of a membrane, may increaſe thoſe in the neighbouring muſcles. But it ſeems alſo, that a ceſſation of vibrations in any other conſiderable part of the body, from whatever cauſe it proceeds, has a like tendency; and that this tendency is deducible from the change made in the nerves of the part affected, and thence propagated into the communicating branches, or even into the whole medullary ſubſtance. The yawnings and ſtretchings of perſons diſpoſed to ſleep, the convulſive reſpiration of thoſe that are juſt fallen aſleep, and the convulſive motions which attend the extinction

tion of the ſenſes in epileptic fits, and the near approaches of death, may be derived, perhaps, in part, from this ſource, in part from ſome of the foregoing.

PROP. XIX.

The automatic Motion ſeems to admit of a commodious Explanation, from the three laſt Propoſitions taken together.

THE particular detail of this obſcure and intricate matter will be attempted in the proper places of the next chapter, which will contain the application of the general poſitions concerning ſenſation and motion, in this, to each of the moſt remarkable phænomena conſidered ſeparately. I will, however, preſent the reader here with a ſhort ſketch, to enable him to form ſome notion of the manner and plauſibility of the attempt.

The ordinary motions of the heart appear to ariſe from the ſecond and third claſſes of motory vibrations, mentioned in the laſt propoſition; and it is remarkable, that its motions are found to be, in general, and *cæteris paribus*, ſtronger or weaker, as the ſum total of theſe two claſſes is greater or leſs. The ſyſtole and diaſtole ſucceed each other, from the cauſes aſſigned in the ſeventeenth propoſition. We are to conceive, however, that both the influx of the venal blood into the ventricles, and of the arterial into the coronary veſſels, have a conſiderable ſhare in bringing on the ſyſtole, in the way of diſtention and irritation.

May we not conjecture, from that experiment of Dr. *Hook*'s, in which he kept a dog alive, by a mere continued ſtream of freſh air paſſing through the lungs, without any ſuch alternate motion of the cheſt as takes place in common reſpiration, that one principal uſe of the air, which is an electric *per ſe*, in reſpiration, is to reſtore to the blood, as it paſſes through the lungs, that electricity which it has loſt in circulating through the body? For, upon this ſuppoſition, the blood which arrives at the left ventricle, will, in ceſſations of reſpiration, and alſo where foul air is reſpired, want its due electricity; whence, according to *prop.* 16. the muſcles, and eſpecially the heart, will want one of the principal requiſites for contraction. However, convulſive motions may enſue after a ſyncope, from the fifth claſs of motory vibrations.

It is remarkable here, that the hearts of frogs, vipers, and ſeveral other ſuch animals, as can live in great degrees of cold, and without reſpiration, continue to beat, as has been taken notice of above, for a long time after they are taken out of their bodies. We muſt therefore ſuppoſe, that the fibres of their hearts, and the blood globules which remain in them, are endued with an electric, or other attractive virtue, of a more durable kind than the fibres and blood globules of the more perfect animals; alſo, that this virtue may be put into action by a leſs degree of heat. All which is very agreeable to the other circumſtances of their œconomy.

Reſpiration and crying are excited in the new-born child from the cold, handling of the midwife, and other vivid ſenſations impreſſed immediately upon its coming into the world. Theſe vivid ſenſations put the whole ſyſtem of muſcles, or at leaſt thoſe of the trunk and larynx, into action at once, as far as their mutual antagoniſm will permit, the ſtronger ſet of conſpiring muſcles over-powering the weaker for a certain ſhort time, and then after their force is exhauſted, according to *prop.* 17. giving way for a ſhorter time to the weaker. But this alternate action of the muſcles of the trunk and larynx will be an imperfect kind of reſpiration, with crying, as may be eaſily ſeen from the diſpoſition of the muſcles. Reſpiration is afterwards kept up, partly by the propenſity of the muſcles to alternate action, explained *prop.* 17. partly, perhaps, by the power of habit, *i. e.* aſſociation; partly by the renewal of vivid impreſſions; and partly, as it ſeems, by vibrations excited in the pleura and peritonæum, and thence communicated to the diaphragm, and to the muſcles of the breaſt and belly.

That the laſt cauſe has a real efficacy, may appear from the following inſtance. Let reſpiration be ſuppoſed to be at a ſtand for a ſmall time, on account of the perſon's running, or exerting an act of great ſtrength. It is evident, that the blood will both be accumulated in the lungs, and heated there, during this interruption of reſpiration, ſince reſpiration both ventilates the blood, and promotes its motion through the lungs. The external membrane of the lungs will therefore be both diſtended and heated, *i. e.* will have an increaſe of vibrations communicated to it. But this membrane is continuous to the pleura, and, indeed, is the ſame membrane with it. An increaſe of vibrations will therefore be communicated to the pleura, and conſequently to the diaphragm, and muſcles of the breaſt, which it inveſts.

The periſtaltic motion of the inteſtines is, in part, to be deduced from the ſecond and third claſſes of motory vibrations, in the ſame manner as the motion of the heart, ſince that motion, like this, returns at intervals inceſſantly. And there is reaſon to believe, that vigorous vibrations, either of the ſenſory or ideal kind, impart an extraordinary degree of activity to the ſtomach and bowels. However, they derive alſo a great part of their motions, probably the major part, from the impreſſions which the aliment, bile, and fæces, make upon the villous coat, the vibrations excited by theſe impreſſions both running directly into the muſcular coat, for the purpoſe of contracting that part which adjoins to the ſeat of impreſſion, and alſo running upwards and downwards along the villous coat, ſo as to exert ſome efficacy at a diſtance from this ſeat.

It is very remarkable that the pale fibres of the inteſtines, in men, and many other animals, preſerve their power of alternate contraction and relaxation for a conſiderable time after death, whereas the red fleſhy muſcles of the ſame animals loſe theirs ſoon after the effuſion of their blood. It is a phænomenon of a like kind with this, that the whole muſcular ſyſtem of ſome animals, that are exanguious, or nearly ſo, retain their activity for a conſiderable time after theſe animals are cut into pieces. And both may ſerve to intimate, that the electricity, or other attractive virtue, of pale fibres and fluids, at the ſame time that it is feebler than that of red ones, is, however, of a more durable kind, and, as was obſerved above of the hearts of frogs and vipers, capable of being put into action by a leſs degree of heat.

The actions of ſneezing, ſwallowing, coughing, hiccoughing, vomiting, and expelling the fæces and urine, with others of a like nature, are to be deduced from the firſt and fourth claſſes of motory vibrations, *i. e.* either from thoſe vibrations which firſt aſcend up the ſenſory nerves, and then are detached down the motory nerves which communicate with theſe by ſome common trunk, plexus, or ganglion, or elſe from thoſe vibrations that run along the ſurfaces of uniform membranes, and ſo affect all the muſcles which lie contiguous to any part of theſe membranes. It is a ſtrong argument in favour of the hypotheſis here delivered, that all the above-mentioned motions ariſe in the neighbourhood of vivid ſenſations, increaſe when they increaſe, and languiſh when they languiſh.

In examining this hypotheſis by the actions of ſneezing, ſwallowing, and coughing, regard muſt be had to the noſe, uvula, and epiglottis, reſpectively, as being extreme and pointed parts, and conſequently liable to be affected with extraordinary vibrations, agreeably to the ninth phænomenon of the ſixth propoſition.

see Note Page 4th. Vol: 3.

In like manner, the numerous plexuſes and ganglions of the eighth pair of nerves and intercoſtal nerve muſt have great influence in the motions and functions of the parts contained in the thorax and belly.

As the motory vibrations of the ſecond and third claſſes are of a gentle kind, for the moſt part, and deſcend conſtantly into the whole ſyſtem of the muſcles, it may be expected, that young children ſhould move all their limbs at times, with ſome irregular kind of ſucceſſion, from this cauſe. And this ſeems to be the fact. Strong contractions of the limbs are often excited by frictions, gripes, and other vivid ſenſations; but then the motory vibrations here are thoſe of the firſt and fourth claſſes. General convulſions, from acidities, and other irritations in the bowels, ſeem to be excited in the ſame way, the intercoſtal nerve ſerving to communicate the vibrations with more readineſs to the muſcles of the trunk and limbs.

It appears to me alſo, that the intercoſtal nerve, which makes thoſe of each ſide a ſeparate ſyſtem, as it were, has ſome ſhare in determining hemiplegias to one ſide. In like manner, the great brachial and crural ganglions make all the nerves of the ſame limb ſympathize with one another.

Whether the nerves of the ſame names throughout the body have not ſome ſympathetic influences over each other, may be doubted. If thoſe of the right ſide ariſe from the left part of the brain, and *vice verſâ*, which ſeems to be the opinion of the beſt anatomiſts, then one would imagine, that the homonymous nerves of the right and left ſides muſt, in croſſing over, lie ſomewhere contiguous to each other, and ſo impart vibrations to each other. And there ſeem to be ſome facts from whence this may be inferred; but we cannot expect to be able to diſtinguiſh, with certainty, ſo feeble an influence, amidſt ſo many others that are far ſtronger.

Yawning and ſtretching may, perhaps, when conſidered in all their circumſtances, take in all the five claſſes of motory vibrations. When they happen in the attacks of fever-fits, and other morbid caſes, the firſt ſeems to be owing to pretty ſudden and ſtrong contractions in the membrane of the mouth, fauces, aſpera arteria, and oeſophagus; the laſt to contractions in the whole ſkin.

As the bowels derive their periſtaltic motion, in part, from the ſecond and third claſſes, ſo it ſeems, that the ſecretory and excretory veſſels of the glands muſt be conſtantly agitated with a like motion, from the ſame cauſes, performing their ordinary ſecretions and excretions thereby. Their extraordinary ones are generally owing to irritations in the membranes, in which the mouths of their excretory veſſels lie. And this agrees remarkably with the doctrine of vibrations. For the vivid vibrations excited in the membranes by the irritating cauſe muſt diffuſe themſelves every way; and when they come to the mouths of the excretory veſſels, penetrate them, and, by paſſing up into the veſſels, both excretory and ſecretory, greatly increaſe their periſtaltic motion, and, by conſequence, their ſecretions and excretions. All this ſeems equally to hold, in reſpect of the exhaling and abſorbing veſſels diſperſed throughout the body.

The external motions of the eyes in young children are probably owing, in part at leaſt, to the immediate action of light upon the tendinous expanſions of the four ſtrait muſcles, and particularly upon thoſe of the *adducens* and *abducens*. But the light which paſſes through the pupil ſeems alſo to have ſome ſhare, as will be ſhewn hereafter. As to the internal motions, it appears, that the light which falls upon the *cornea* and *uvea* muſt excite the greater and leſſer rings to contraction, in proportion to its ſtrength, and conſequently prepare the eye to ſee diſtinctly, at different diſtances, in the manner explained by Dr. *Jurin*. The hypotheſis of this propoſition does therefore give and receive light from his ingenious theory of this matter.

The two muſcles which relax the *membrana tympani*, are much more expoſed to the air than the *muſculus internus*, or the *muſculus ſtapedis*. When therefore the air is agitated with ſtrong vibrations, as in loud ſounds, it will excite the firſt named muſcles to action, and conſequently relax the *membrana tympani*, as it ought to do. For what reaſons the laſt-named muſcles are contracted in feeble ſounds, is a queſtion of a more difficult nature, as is the parallel one in the eye, viz. why the radiated fibres of the *uvea* are contracted in ſmall degrees of light, ſo as then to dilate the pupil.

The reader is deſired to take notice, that, in all the inſtances of this propoſition, I conſider the motions as merely automatic. Their voluntary and ſemivoluntary ſtate will be accounted for in the two next propoſitions.

PROP. XX.

All that has been delivered above, concerning the Derivation of ideal Vibratiuncles from ſenſory Vibrations and concerning their Aſſociations, may be fitly applied to motory Vibrations and Vibratiuncles.

THIS propoſition is the immediate conſequence of admitting the doctrines of vibrations and aſſociation, in the manner in which they have been aſſerted in the foregoing propoſitions. It contains the theory of the voluntary and ſemivoluntary motions; to facilitate the application of which theory in the next propoſition, I ſhall deliver the principal caſes of this, in the following corollaries.

COR. 1. The motory vibrations of the five claſſes mentioned *prop.* 18. will generate a propenſity to correſponding motory vibratiuncles.

COR. 2. Theſe motory vibratiuncles will affect the brain, as well as the motory nerves along which they deſcend; and, indeed, their deſcent along the motory nerves will be principally owing to their being firſt excited in the brain. This is ſufficiently evident in the motory vibratiuncles which are derived from the motory vibrations of the ſecond and third claſſes. As to the motory vibrations of the other claſſes, it is evident, that the brain is ſtrongly affected by the ſenſory vibrations which give birth to them, and conſequently, that a proportional affection of the brain muſt take place in the motory vibratiuncles derived from them.

COR. 3. The motory vibratiuncles will cohere to one another, by aſſociations both ſynchronous and ſucceſſive. Hence the ſimple parts, of which complex and decomplex motions are compounded, may cohere cloſely, and ſucceed readily to each other.

Cor. 4. The motory vibratiuncles will alſo cohere to ideal ones by aſſociation. Common ideas may therefore excite motory vibratiuncles, and conſequently be able to contract the muſcles, provided the active powers lodged in their fibres and blood globules be ſufficiently exalted for this purpoſe.

Cor. 5. If we ſuppoſe the ideal vibratiuncles to be ſo much increaſed, from the cauſes mentioned *prop.* 14. as to be equal in ſtrength to the uſual ſenſory vibrations, the motory vibratiuncles connected with them by aſſociation muſt be ſuppoſed to be increaſed proportionably. Hence ideas may occaſion muſcular motions of the ſame ſtrength with the automatic motions.

Cor. 6. The third and laſt connection of the motory vibratiuncles is that with ſenſory vibrations, foreign to them, *i. e.* ſuch as had no ſhare in generating the motory vibratiuncles under conſideration. Particular motions of the body may therefore by aſſociation be made to depend upon ſenſations, with which they have no natural and original connection.

Cor. 7. As muſcular motion has three connections deducible from aſſociation, viz. thoſe mentioned in the third, fourth, and ſixth corollaries, ſo the ſenſations and ideas have the ſame three connections. Hence the whole doctrine of aſſociation may be compriſed in the following theorem, viz.

If any ſenſation A, *idea* B, *or muſcular motion* C, *be aſſociated for a ſufficient number of times with any other ſenſation* D, *idea* E, *or muſcular motion* F, *it will, at laſt, excite* d, *the ſimple idea belonging to the ſenſation* D, *the very idea* E, *or the very muſcular motion* F.

The reader will obſerve, that aſſociation cannot excite the real ſenſation *D*, becauſe the impreſſion of the ſenſible object is neceſſary for this purpoſe. However, in certain morbid caſes, the idea is magnified ſo as to equal, or even over-power, ſenſible impreſſions.

PROP.

PROP. XXI.

The voluntary and ſemivoluntary Motions are deducible from Aſſociation, in the Manner laid down in the laſt Propoſition.

IN order to verify this propoſition, it is neceſſary to inquire, what connections each automatic motion has gained by aſſociation with other motions, with ideas, or with foreign ſenſations, according to the third, fourth, and ſixth corollaries of the laſt propoſition, ſo as to depend upon them, *i. e.* ſo as to be excited no longer, in the automatic manner deſcribed in the nineteenth propoſition, but merely by the previous introduction of the aſſociated motion, idea, or ſenſation. If it follows that idea, or ſtate of mind (*i. e.* ſet of compound vibratiuncles), which we term the will, directly, and without our perceiving the intervention of any other idea, or of any ſenſation or motion, it may be called voluntary, in the higheſt ſenſe of this word. If the intervention of other ideas, or of ſenſations and motions (all which we are to ſuppoſe to follow the will directly), be neceſſary, it is imperfectly voluntary; yet ſtill it will be called voluntary, in the language of mankind, if it follow certainly and readily upon the intervention of a ſingle ſenſation, idea, or motion, excited by the power of the will: but if more than one of theſe be required, or if the motion do not follow with certainty and facility, it is to be eſteemed leſs and leſs voluntary, ſemivoluntary, or ſcarce voluntary at all, agreeably to the circumſtances. Now, if it be found, upon a careful and impartial inquiry, that the motions which occur every day in common life, and which follow the idea called the will, immediately or mediately, perfectly or imperfectly, do this, in proportion to the number and degree of ſtrength in the aſſociations, this will be ſufficient authority for aſcribing all which we call voluntary in actions to aſſociation, agreeably to the purport of this propoſition. And this, I think, may be verified from facts, as far as it is reaſonable to expect, in a ſubject of inquiry ſo novel and intricate.

In the ſame manner as any action may be rendered voluntary, the ceſſation from any, or a forcible reſtraint upon any, may be alſo, viz. by proper aſſociations with the feeble vibrations in which inactivity conſiſts, or with the ſtrong action of the antagoniſt muſcles.

After the actions, which are moſt perfectly voluntary, have been rendered ſo by one ſet of aſſociations, they may, by another, be made to depend upon the moſt diminutive ſenſations, ideas, and motions, ſuch as the mind ſcarce regards, or is conſcious of; and which therefore it can ſcarce recollect the moment after the action is over. Hence it follows, that aſſociation not only converts automatic actions into voluntary, but voluntary ones into automatic. For theſe actions, of which the mind is ſcarce conſcious, and which follow mechanically, as it were, ſome precedent diminutive ſenſation, idea, or motion, and without any effort of the mind, are rather to be aſcribed to the body than the mind, *i. e.* are to be referred to the head of automatic motions. I ſhall call them automatic motions of the ſecondary kind, to diſtinguiſh them both from thoſe which are originally automatic, and from the voluntary ones; and ſhall now give a few inſtances of this double tranſmutation of motions, viz. of automatic into voluntary, and of voluntary into automatic.

The fingers of young children bend upon almoſt every impreſſion which is made upon the palm of the hand, thus performing the action of graſping, in the original automatic manner. After a ſufficient repetition of the motory vibrations which concur in this action, their vibratiuncles are generated, and aſſociated ſtrongly with other vibrations or vibratiuncles, the moſt common of which, I ſuppoſe, are thoſe excited by the ſight of a favourite play-thing which the child uſes to graſp, and hold in his hand. He ought, therefore, according to the doctrine of aſſociation, to perform and repeat the action of graſping, upon having ſuch a play-thing preſented to his ſight. But it is a known fact, that children do this. By purſuing the ſame method of reaſoning, we may ſee how, after a ſufficient repetition of the proper aſſociations, the ſound of the words *graſp*, *take hold*, &c. the ſight of the nurſe's hand in a ſtate of contraction, the idea of a hand, and particularly of the child's own hand, in that ſtate, and innumerable other aſſociated circumſtances, *i. e.* ſenſations, ideas, and motions, will put the child upon graſping, till, at laſt, that idea, or ſtate of mind which we may call the will to graſp, is generated, and ſufficiently aſſociated with the action to produce it inſtantaneouſly. It is therefore perfectly voluntary in this caſe; and, by the innumerable repetitions of it in this perfectly voluntary ſtate, it comes, at laſt, to obtain a ſufficient connection with ſo many diminutive ſenſations, ideas, and motions, as to follow them in the ſame manner as originally automatic actions do the correſponding ſenſations, and conſequently to be automatic ſecondarily. And, in the ſame manner, may all the actions performed with the hands be explained, all thoſe that are very familiar in life paſſing from the original automatic ſtate through the ſeveral degrees of voluntarineſs till they become perfectly voluntary, and then repaſſing through the ſame degrees in an inverted order, till they become ſecondarily automatic on many occaſions, though ſtill perfectly voluntary on ſome, *viz.* whenſoever an expreſs act of the will is exerted.

I will, in the next place, give a ſhort account of the manner in which we learn to ſpeak, as it may be deduced from the foregoing propoſition. The new-born child is not able to produce a ſound at all, unleſs the muſcles of the trunk and larynx be ſtimulated thereto by the impreſſion of pain on ſome part of the body. As the child advances in age, the frequent returns of this action facilitate it; ſo that it recurs from leſs and leſs pains, from pleaſures, from mere ſenſations, and laſtly, from ſlight aſſociated circumſtances, in the manner already explained. About the ſame time that this proceſs is thus far advanced, the muſcles of ſpeech act occaſionally, in various combinations, according to the aſſociations of the motory vibratiuncles with each other. Suppoſe now the muſcles of ſpeech to act in theſe combinations at the ſame time that ſound is produced from ſome agreeable impreſſion, a mere ſenſation, or a ſlight aſſociated cauſe, which muſt be ſuppoſed to be often the caſe, ſince it is ſo obſervable, that young children, when in a ſtate of health and pleaſure, exert a variety of actions at the ſame time. It is evident, that an articulate ſound, or one approaching thereto, will ſometimes be produced by this conjoint action of the muſcles of the trunk, larynx, tongue, and lips; and that both theſe articulate ſounds, and inarticulate ones, will often recur, from the recurrence of the ſame accidental cauſes. After they have recurred a ſufficient number of times, the impreſſion which theſe ſounds, articulate and inarticulate, make upon the ear, will become an aſſociated circumſtance (for the child always hears himſelf ſpeak, at the ſame time that he exerts the action) ſufficient to produce a repetition of them. And thus it is, that children repeat the ſame ſounds over and over again, for many ſucceſſions, the impreſſion of the laſt ſound upon the ear exciting a freſh one, and ſo on, till the organs be tired. It follows therefore, that if any of the attendants make any of the ſounds familiar to the child, he will be excited from this impreſſion, conſidered as an aſſociated circumſtance, to return it. But the attendants make articulate ſounds chiefly; there will therefore be a conſiderable balance in favour of ſuch, and that of a growing nature: ſo that the child's articulate ſounds will be more and more frequent every day—his inarticulate ones grow into diſuſe. Suppoſe now, that he compounds theſe ſimple articulate ſounds, making complex ones, which approach to familiar words at ſome times, at others ſuch as are quite foreign to the words of his native language, and that the firſt get an ever-growing balance in their favour, from the cauſe juſt now taken notice of; alſo, that they are aſſociated with viſible objects, actions, &c. and it will be eaſily ſeen, that the young child ought, from the nature of aſſociation, to learn to ſpeak much in the ſame manner as he is found in fact to do. Speech will alſo become a perfectly voluntary action, *i. e.* the child will be able to utter any word or ſentence propoſed to him by others, or by himſelf, from a mere exertion of the will, as much as to graſp: only here the introductory circumſtance, viz. the impreſſion of the ſound on the ear, the idea of this ſound, or the preceding motion in pronouncing the preceding word, is evident; and therefore makes it probable, that the ſame thing takes place in other caſes. In like manner, ſpeech, after it has been voluntary for a due time, will become ſecondarily automatic, *i. e.* will follow aſſociated circumſtances, without any expreſs exertion of the will.

From the account here given of the actions of handling and ſpeaking, we may underſtand in what manner the firſt rudiments are laid of that faculty of imitation, which is ſo obſervable in young children. They ſee the actions of their own hands, and hear themſelves pronounce. Hence the impreſſions made by themſelves on their own eyes and ears become aſſociated circumſtances, and conſequently muſt, in due time, excite to the repetition of the actions. Hence like impreſſions made on their eyes and ears by others, will have the ſame effect; or, in other words, they will learn to imitate the actions which they ſee, and the ſounds which they hear.

In the ſame manner may be explained the evident powers which the will has over the actions of ſwallowing, breathing, coughing, and expelling the urine and fæces, as well as the feeble and imperfect ones over ſneezing, hiccoughing, and vomiting. As to the motion of the heart, and periſtaltic motion of the bowels, ſince they are conſtant, they muſt be equally aſſociated with every thing, *i. e.* peculiarly ſo with nothing, a few extraordinary caſes excepted. They will therefore continue to move ſolely in the original automatic manner, during the whole courſe of our lives. However, aſſociation may, perhaps, have ſome ſhare in keeping theſe motions, and that of reſpiration, up for a time, when the uſual automatic cauſes are deficient in any meaſure; and may thus contribute to their equability and conſtancy. It ſeems certain, at leaſt, that where unequable and irregular motions of the heart and bowels are generated, and made to recur for a ſufficient number of times, from their peculiar cauſes, in full quantity, a leſs degree of the ſame cauſes, or even an aſſociated circumſtance, will ſuffice to introduce them afterwards. And the ſame thing may be obſerved of hyſteric and epileptic fits. Theſe recur from leſs and leſs cauſes perpetually, in the ſame manner, and for the ſame reaſons, as original automatic motions are converted into voluntary ones.

I will add one inſtance more of the tranſition of voluntary actions into automatic ones of the ſecondary kind, in order to make that proceſs clearer, by having it ſingly in view. Suppoſe a perſon who has a perfectly voluntary command over his fingers, to begin to learn to play upon the harpſicord: the firſt ſtep is to move his fingers from key to key, with a ſlow motion, looking at the notes, and exerting an expreſs act of volition in every motion. By degrees the motions cling to one another, and to the impreſſions of the notes, in the way of aſſociation ſo often mentioned, the acts of volition growing leſs and leſs expreſs all the time, till at laſt they become evaneſcent and imperceptible. For an expert performer will play from notes, or ideas laid up in the memory, or from the connection of the ſeveral complex parts of the decomplex motions, ſome or all; and, at the ſame time, carry on a quite different train of thoughts in his mind, or even hold a converſation with another. Whence we may conclude, that the paſſage from the ſenſory, ideal, or motory vibrations which precede, to thoſe motory ones which follow, is as ready and direct, as from the ſenſory vibrations to the original automatic motions correſponding to them; and conſequently, that there is no intervention of the idea, or ſtate of mind, called will. At leaſt, the doctrine of aſſociation favours this, and the fact ſhews, that there is no perceptible intervention, none of which we are conſcious.

And thus, from the preſent propoſition, and the nineteenth taken together, we are enabled to account for all the motions of the human body, upon principles which, though they may be fictitious, are, at leaſt, clear and intelligible. The doctrine of vibrations explains all the original automatic motions, that of aſſociation the voluntary and ſecondarily automatic ones. And, if the doctrine of aſſociation be founded in, and deducible from, that of vibrations, in the manner delivered above, then all the ſenſations, ideas, and motions, of all animals, will be conducted according to the vibrations of the ſmall medullary particles. Let the reader examine this hypotheſis by the facts, and judge for himſelf. There are innumerable things, which, when properly diſcuſſed, will be ſufficient teſts of it. It will be neceſſary, in examining the motions, carefully to diſtinguiſh the automatic ſtate from the voluntary one, and to remember, that the firſt is not to be found pure, except in the motions of the new-born infant, or ſuch as are excited by ſome violent irritation or pain.

Cor. 1. The brain, not the ſpinal marrow, or nerves, is the ſeat of the ſoul, as far as it preſides over the voluntary motions. For, by *Cor.* 2. of the laſt *Propoſition*, the efficacy of the motory vibratiuncles depends chiefly on that part of them which is excited within the brain.

Cor. 2. The hypotheſis here propoſed is diametrically oppoſite to that of *Stahl*, and his followers. They ſuppoſe all animal motions to be voluntary in their original ſtate, whereas this hypotheſis ſuppoſes them all to be automatic at firſt, *i. e.* involuntary, and to become voluntary afterwards by degrees. However, the *Stahlians* agree with me concerning the near relation of theſe two ſorts of motion to each other, as alſo concerning the tranſition (or rather return, according to my hypotheſis) of voluntary motions into involuntary ones, or into thoſe which I call ſecondarily automatic. As to final cauſes, which are the chief ſubject of inquiry amongſt the *Stahlians*, they are, without doubt, every where conſulted, in the ſtructure and functions of the parts; they are alſo of great uſe for diſcovering the efficient ones. But then they ought not to be put in the place of the efficient ones; nor ſhould the ſearch after the efficient be baniſhed from the ſtudy of phyſic, ſince the power of the phyſician, ſuch as it is, extends to theſe alone. Not to mention, that the knowledge of the efficient cauſes is equally uſeful for diſcovering the final, as may appear from many parts of theſe obſervations.

Cor. 3. It may afford the reader ſome entertainment, to compare my hypotheſis with what *Des Cartes* and *Leibnitz* have advanced, concerning animal motion, and the connection between the ſoul and body. My general plan bears a near relation to theirs. And it ſeems not improbable to me, that *Des Cartes* might have had ſucceſs in the execution of his, as propoſed in the beginning of his Treatiſe on Man, had he been furniſhed with a proper aſſemblage of facts from anatomy, phyſiology, pathology, and philoſophy in general. Both *Leibnitz*'s Pre-eſtabliſhed Harmony, and *Malebranche*'s Syſtem of occaſional Cauſes, are free from that great difficulty of ſuppoſing, according to the ſcholaſtic ſyſtem, that the ſoul, an immaterial ſubſtance, exerts and receives a real phyſical influence upon and from the body, a material ſubſtance. And the reader may obſerve, that the hypotheſis here propoſed ſtands clear alſo of this difficulty. If he admits the ſimple caſe of the connection between the ſoul and body, in reſpect of ſenſation, as it is laid down in the firſt propoſition; and only ſuppoſes, that there is a change made in the medullary ſubſtance, proportional and correſpondent to every change in the ſenſations; the doctrine of vibrations, as here delivered, undertakes to account for all the reſt, the origin of our ideas and motions, and the manner in which both the ſenſations and theſe are performed.

COR. 4. I will here add Sir *Iſaac Newton*'s words, concerning ſenſation and voluntary motion, as they occur at the end of his *Principia*, both becauſe they firſt led me into this hypotheſis, and becauſe they flow from it as a corollary. He affirms then, "both "that all ſenſation is performed, and alſo the limbs "of animals moved in a voluntary manner, by the "power and actions of a certain very ſubtle ſpirit, "*i. e.* by the vibrations of this ſpirit, propagated "through the ſolid capillaments of the nerves from "the external organs of the ſenſes to the brain, and "from the brain into the muſcles."

COR. 5. It follows from the account here given of the voluntary and ſemivoluntary motions, that we muſt get every day voluntary and ſemivoluntary powers, in reſpect of our ideas and affections. Now this conſequence of the doctrine of aſſociation is alſo agreeable to the fact. Thus we have a voluntary power of attending to an idea for a ſhort time, of recalling one, of recollecting a name, a fact, &c. a ſemivoluntary one of quickening or reſtraining affections already in motion, and a moſt perfectly voluntary one of exciting moral motives, by reading, reflection, &c.

PROP. XXII.

It follows, from the Hypotheſis here propoſed, concerning the voluntary Motions, that a Power of obtaining Pleaſure, and removing Pain, will be generated early in Children, and increaſe afterwards every Day.

For the motions which are previous and ſubſervient to the obtaining of pleaſure, and the removal of pain, will be much more frequent, from the very inſtant of birth, than thoſe which occaſion pain. The number alſo of the firſt will be perpetually increaſing, of the laſt decreaſing. Both which poſitions may be evinced by the following arguments.

Firſt, The pleaſures are much more numerous than the pains. Hence the motions which are ſubſervient to them are much more numerous alſo.

Secondly, The aſſociated circumſtances of the pleaſures are many more in number than the pleaſures themſelves. But theſe circumſtances, after a ſufficient aſſociation, will be able to excite the motions ſubſervient to the pleaſures, as well as theſe themſelves. And this will greatly augment the methods of obtaining pleaſure.

Thirdly, It favours the poſition here advanced, that the motions ſubſervient to pleaſure are of a moderate nature; and therefore, that they can be excited with the more eaſe, both in an automatic and voluntary manner.

Fourthly, The pains, and conſequently the motions ſubſervient to them, are few, and of a violent nature. Theſe motions are alſo various, and therefore cannot be united to objects and ideas with conſtancy and ſteadineſs; and, which is moſt to be regarded, they end, at laſt, from the very make of the body, in that ſpecies of motion which contributes moſt to remove or aſſuage the pain. This ſpecies therefore, ſince it recurs the moſt frequently, and continues longeſt, muſt be confirmed by aſſociation, to the excluſion of the reſt..

Cor. 1. Many changes in the actions of young children, very difficult to be explained, according to the uſual methods of conſidering human actions, appear to admit of a ſolution from this propoſition. Theſe changes are ſuch as tend to the eaſe, convenience, pleaſure, of the young child; and they are ſufficiently obſervable in the tranſition of the originally automatic actions into voluntary ones, as matters of fact, whatever be determined concerning their cauſe. I ſhall therefore refer to them occaſionally, in the courſe of theſe papers, as allowed matters of fact.

Cor. 2. It ſeems alſo, that many very complex propenſities and purſuits in adults, by which they ſeek their own pleaſure and happineſs, both explicitly and implicitly, may be accounted for, upon the ſame, or ſuch-like principles.

Cor. 3. To ſimilar cauſes we muſt alſo refer that propenſity to excite and cheriſh grateful ideas and affections, and trains of theſe, which is ſo obſervable in all mankind. However, this does not hold in ſo ſtrict a manner, but that ungrateful trains will preſent themſelves, and recur on many occaſions, and particularly whenever there is a morbid, and ſomewhat painful, ſtate of the medullary ſubſtance.

Cor. 4. Since God is the ſource of all good, and conſequently muſt at laſt appear to be ſo, *i. e.* be aſſociated with all our pleaſures, it ſeems to follow, even from this propoſition, that the idea of God, and of the ways by which his goodneſs and happineſs are made manifeſt, muſt, at laſt, take place of, and abſorb all other ideas, and HE himſelf become, according to the language of the ſcriptures, *all in all.*

Cor. 5. This propoſition, and its corollaries, afford ſome very general, and perhaps new, inſtances of the coincidence of efficient and final cauſes.

Cor. 6. The agreement of the doctrines of vibrations and aſſociation, both with each other, and with ſo great a variety of the phænomena of the body and mind, may be reckoned a ſtrong argument for their truth.

CHAP. II.

Containing the Application *of the* Doctrines *of* Vibrations *and* Association *to each of the* Sensations *and* Motions, *in particular.*

SECT. I.

OF THE SENSE OF FEELING.

PROP. XXIII.

To dinſtinguiſh the ſeveral Kinds of Feeling *from each other, and to aſſign the general Cauſes of the different Degrees of Exquiſiteneſs in this Senſe.*

Here we may firſt diſtinguiſh feeling into the general and particular.

The general feeling extends to all the parts of the body, external and internal: for they are all ſuſceptible of pain from wounds and inflammations, of being put into a pleaſurable ſtate, of numbneſs, and total want of ſenſation, and of perceiving heat, cold, and preſſure. Some writers conſider all the ſenſations of all the ſenſes as ſo many kinds of feeling; but I do not here uſe this word in ſo extenſive an acceptation.

The particular feeling is that more exquiſite degree which reſides in the inſides of the hands, and eſpecially in the ends of the fingers; and by which we diſtinguiſh the tangible qualities of bodies, viz. heat, cold, moiſture, dryneſs, ſoftneſs, hardneſs, ſmoothneſs, roughneſs, alſo their motion, reſt, diſtance, and figure, with more accuracy than by any other part. Theſe ſenſations are, for the moſt part, adiaphorous ones.

The greater exquiſiteneſs of the particular feeling ariſes probably from the following cauſes:

Firſt, The ſentient *papillæ* riſe high from the ſkin (becoming extreme parts thereby), and receive a large proportional quantity of nerves in the ends of the fingers.

Secondly, The ends of the fingers are themſelves extreme parts, and conſequently receive ſtronger agitations in their infiniteſimal medullary particles, from the ſtronger vibrations of the contiguous denſer æther. For we muſt ſuppoſe, that the vibrations of the rarer æther within the nerves extend themſelves a little way into the denſer ſurrounding æther, and even become ſtronger to a certain diſtance; after which they become weaker again, and are, at laſt, quite ſuppreſſed by the increaſe of denſity in the æther, and by their own diffuſion.

Thirdly, It is cuſtomary, in endeavouring to feel exquiſitely, to rub the ends of the fingers againſt the tangible object. Now this friction may, by exciting vibrations, and a conſequent contraction in certain muſcular fibrils belonging to the *papillæ*, diſtend and erect theſe, and thereby increaſe their ſenſibility.

Fourthly, There is much here to be aſcribed to practice and habit, *i. e.* to aſſociation; and it is chiefly on this account, that the ſenſations of the ends of the fingers give us ſo much more preciſe information concerning the tangible qualities of bodies, than thoſe of the ends of the toes, ſince the ſtructure of the nervous *papillæ* is alike in both. It ought to be conſidered as a part of this reaſon, that, according to the principles laid down in the laſt chapter, we may get a voluntary power of erecting the *papillæ* without friction, or of increaſing and fixing the diſtention during friction, in order to feel with greater exquiſiteneſs and preciſion.

The ſenſe of feeling may alſo be diſtinguiſhed into that of the external ſurface of the body, and that of the cavities of the noſe, mouth, *fauces*, alimentary duct, *pelvis* of the kidneys, ureters, bladder of urine, gall-bladder, follicles and ducts of the glands, &c. The ſenſibility in the laſt is much greater than in the firſt, becauſe the impreſſions can more eaſily penetrate through the ſoft epithelium, with which the internal cavities are inveſted, than through the hard cuticle, becauſe the compact fibrous membrane of the true ſkin does not ſuffer the vibrations to paſs freely up the nerve through its own ſubſtance, but rather diffuſes them along its ſurface, and becauſe the moiſture of the epithelium diſſolves, and thereby renders active, all the ſaline particles, which touch the internal cavities. In the mouth and noſe this ſenſibility is ſo great, and attended with ſuch diſtinguiſhing circumſtances, as to have the names of taſte and ſmell aſſigned reſpectively to the ſenſations impreſſed upon the *papillæ* of theſe two organs. And as the ſenſations of the alimentary duct have a near relation to, and connection with, thoſe of the mouth, I ſhall refer them to the head of taſte. But the ſenſations of the other internal cavities may be comprehended more properly under feeling.

It ought alſo to be obſerved here, that the lips, nipples, and external parts of generation, have a more exquiſite ſenſibility, than the other external parts; partly from the ſtructure of their *papillæ*, and partly from the thinneſs of the cutis, and ſoftneſs and thinneſs of the cuticle. The extreme ſenſibility of the *cornea* and *tunica conjunctiva* of the eye may ariſe from the manner in which the nerves are here expoſed, and the tenſion of theſe parts.

PROP. XXIV.

To examine how far the Senſations of Heat and Cold are agreeable to the Doctrine of Vibrations.

A BODY is termed *hot*, when its heat exceeds that of the part, with which we touch it; cold, when its heat is leſs than this. The terms *hot* and *cold* are therefore relative ones, and the qualities denoted by them run into each other without any preciſe diſtinguiſhing limits. We may conſequently refer *cold* to *heat*, and, if we admit the doctrine of vibrations, we are to ſuppoſe, that the ſmall parts of all bodies are agitated by ſubtle vibrations; and that when theſe vibrations exceed thoſe of the part with which we touch them, they are called *warm* or *hot*; when they fall ſhort, *cold*.

This may be regarded as a groſs, general poſition, which preſents itſelf upon the firſt conſideration of this matter. But then, as, according to this definition of heat, all thoſe objects of taſte and ſmell, which excite ſtrong vibratory motions in the organs ought to excite heat, we muſt inquire farther into the vibratory motions of bodies termed *hot* in common language, and into the difference between theſe and the vibrations excited in the nerves of taſte and ſmell by ſapid and odorous bodies.

I conjecture therefore, that the vibrations belonging to heat are in general quicker and ſhorter, than the peculiar ones excited by taſtes, ſmells, and colours; alſo that the laſt, or the vibrations of the rays of light, are quicker than thoſe of taſtes and ſmells. We may conceive farther, that all the vibrations of the ſmall particles of the medullary ſubſtance, and interjacent æther, from whatever cauſe they ariſe, grow quicker as they grow ſhorter, *i. e.* weaker; or, according to the conjecture juſt made, that in declining they tend to thoſe which impreſs the ſenſation of heat. For vibratory motions of different lengths can be iſochronous only according to one law, viz. that of the accelerating force being in the ſimple proportion of the diſtance from the middle point of the vibration, as when a heavy body vibrates in a cycloid; whereas, if the accelerating force be in any leſs ratio than this, ſhort vibrations wil be quicker than long ones. Laſtly, we are to conceive, that when two vibrations of different kinds, or frequences, are impreſſed at the ſame time, they muſt reduce one another to ſome ſingle intermediate one, unleſs the quicker be ſo much more numerous than the ſlower, as to be comprehended within them, ſo that both may be performed together without oppoſition or confuſion.

Let us now inquire how far the ſeveral effects of heat and cold upon our bodies are agreeable either to the notion of vibrations in general, or to the particular conjectures of the laſt paragraph.

Firſt, then, We may expect that heat will rarefy the ſolids and fluids of the body, and the laſt more than the firſt, which is agreeable to experience. For the increaſe of the agitations will make the ſmall particles recede from one another, and that more in fluid than in ſolid parts, becauſe of their looſer texture. There may be other reaſons alſo, drawn from the particular unknown compoſition of each part, ſolid and fluid, which may ſubject them to greater or leſs rarefaction. Thus I conjecture, that the red blood is more apt to be rarefied than the other fluids, and that it is by this means made a chief inſtrument in compreſſing the white medullary ſubſtance of the brain, and ſpinal marrow, in natural and morbid ſleep, to both which heat contributes, as has been obſerved already.

Secondly, If heat be cauſed by vibrations, we may expect, that thoſe propagated from the hot or cold body ſhould diffuſe themſelves freely and inſtantaneouſly over the whole nervous ſyſtem, *i. e.* the whole body; however along the ſurface of the ſkin, in an eſpecial manner. This follows from the uniformity both of the whole medullary ſubſtance, and of the ſkin. The firſt communicates the vibrations which aſcend along the nerves affected to the whole body, the laſt thoſe impreſſed upon the part of the ſkin, which touches the hot or cold body, to the other parts of it. Now this is agreeable to experience: for when the whole body is too hot, or too cold, we find that the mere touch of a cold or hot body will give general relief immediately; and in ſome caſes a thrilling or ſhivering may be felt to run along the ſkin.

Thirdly, If the ſkin be contracted by any cauſe different from the direct impreſſion of cold, as by the pain propagated from a wound, the colic, the irritation of a ſtone in the bladder, &c. this contraction, firſt excited by an increaſe of vibrations in the muſcular variouſly interwoven fibrils of the ſkin, may be expected afterwards to check and diminiſh the vibrations there, and thus to occaſion the ſenſation of cold, agreeably to experience. The chillineſs ariſing from matter abſorbed, and from the cauſe of acute diſtempers, whatever that be, may admit of a like explanation.

The tremors, *i. e.* ſudden, ſhort, alternate contractions of the antagoniſt muſcles, which happen in the foregoing caſes, ariſe probably from an increaſe of vibrations, not ſubject to ideas, and the voluntary power, deſcending from the brain into the whole ſyſtem of the muſcles; and ſeem to differ from the ſtronger and larger convulſive motions of hyſteric and epileptic diſorders, called convulſions emphatically, rather in degree than kind. Theſe tremors generally precede the ſenſe of chillineſs, when the contraction of the fibrils of the ſkin does not ariſe from the direct impreſſion of cold.

We may from hence paſs to the ſenſation of chillineſs, and the tremors, which are ſometimes occaſioned by the paſſions, fear, anger, ſurprize, joy, &c. Both the redneſs and the paleneſs of the lips, face, and neck, which are obſervable in theſe caſes, are marks of a contraction in muſcular fibrils; in a leſs degree in the firſt caſe, ſo as to check the return of the venal blood; in a greater in the laſt, ſo as to prevent the influx of the arterial.

Fourthly, It is eaſy to conceive, that heat may occaſion pain, agreeably to the hypotheſis concerning pain, above propoſed. For the ſtrong vibrations excited by great heat muſt put the ſmall parts beyond the ſpheres of each other's attraction, and ſo produce the ſolution of continuity. But neither does it ſeem inconceivable, that cold may have a like effect, agreeably to the doctrine of vibrations, though the proceſs be different. For great cold, by checking the vibrations in the external part, to which it is applied, will alter the ſituation and diſtance of the ſmall medullary particles there, and ſo muſt excite vigorous vibrations in the aſcending nerves, and the correſponding region of the brain, which is juſt the effect occaſioned by heat, applied to the ſame external part. Hence, if we are touched by a very hot, or a very cold body, inadvertently, and without ſeeing it, it ought to be difficult to diſtinguiſh which it is, agreeably to the fact. The conflict between the diminiſhed vibrations, in the external part to which cold is applied, and the previous ones ſubſiſting in the correſponding part of the brain, may exalt theſe previous ones, as much as heat does, ſo as to render the firſt ſimple impreſſion of cold ſimilar to that of heat.

Fifthly, The continued impreſſion of heat makes us more ſenſible of cold. For when heat has rarefied the parts, and adapted them to a peculiar ſtrength and frequency of vibrations, differing from the uſual ſtandard, the cold, whoſe difference from the uſual ſtandard lies on the other ſide, muſt raiſe a greater conflict, and produce a greater change, than if the parts had remained at the uſual ſtandard. The continued impreſſion of cold muſt for the ſame reaſons make us more ſenſible of heat. This explication will perhaps ſuit with other theories of ſenſation, as well as with that drawn from vibrations. However, the mere conſiſtency of any phænomena with the doctrine of vibrations is worthy of ſome attention in this inquiry.

Sixthly, When the calf of the leg is affected with the cramp, ſetting the foot upon a cold marble will afford immediate relief. For the cold may check the violent vibrations in the fibres of the *gaſtrocnemii* and *ſoleus*, directly and immediately; or it may do it by exciting vigorous vibrations of a different kind, which extend to their antagoniſt muſcles, as well as to the fore-mentioned ones. But I judge the firſt account to be more probable.

Seventhly, If a limb, that has been much chilled with cold, be brought to a fire ſuddenly, it will firſt be much pained, and then mortify. For the vibrations excited by the fire, though moderate in reſpect of the uſual ſtandard, are yet exceſſive in reſpect of thoſe which the cold has introduced, alſo in reſpect of that ſphere of attraction, which it has now fixed upon the parts: there will ariſe therefore a violent conflict, ſolution of continuity, and conſequent pain; and the parts will be agitated ſo much more than their preſent ſpheres of attraction will permit, that they cannot return to it any more, but muſt be entirely diſunited, and run into different combinations, *i. e.* the limb muſt mortify. But, if the limb be put into cold water, rubbed, and gradually exalted to the uſual ſtandard of heat, it may be perſerved. Where it is to be obſerved, that the heat of water, while fluid, is above the freezing point, and, conſequently, greater than that of a frozen limb.

It may ſomewhat confirm this reaſoning, to give a ſimilar explication of ſome of the phænomena of glaſs bubbles, made by dropping melted glaſs into water. We may ſuppoſe then, that theſe fall at once into powder, when broken at their points, becauſe the cold water has ſo far reduced the ſphere of attraction, that all the parts of the bubbles are agitated beyond this, by breaking their points. But if a bubble be heated, and its parts brought to a larger ſphere of attraction by the agitations from heat, it will no longer fall to powder when broken at its point. It may alſo have its parts ground away at pleaſure, without falling to powder, becauſe grinding agitates all the contiguous parts with ſtrong vibrations, like heat, and enlarges the ſphere of their attractions.

Eighthly, When the parts contiguous to a mortified ſlough have a ſufficient heat in them, excited by the *vis vitæ*, or warm applications, the vibrations attending this life and heat of the parts ought to help to ſhake off and ſeparate the mortified ſlough, *i. e.* to ſtop the mortification; which is agreeable to the fact. Hence mortifications from external cold, in bodies otherwiſe healthy, will come to ſeparate ſooneſt, and moſt perfectly; as it is frequently ſeen in cold climates. Hence alſo mortifications happening in the acute diſtempers of young perſons, if they ſtop at all, ſtop ſooner than thoſe in the extreme parts of old perſons.

Ninthly, It is ſaid, that cold water, ſprinkled upon the diſtended limbs of malefactors upon the rack, renews and augments their pains. Now, we may here ſuppoſe, that the parts had, in ſome meaſure, begun to accommodate themſelves to their diſtended ſtate, by getting new and enlarged ſpheres of action: when therefore the cold water endeavours to contract the parts again, and to narrow the ſpheres of action, the limbs ſtill continuing diſtended by the rack, it is evident, that a ſtrong conflict, with violent vibrations, and the ſolution of continuity, muſt enſue. Was the limb releaſed firſt, and then cold water applied, it might contribute, as in ſprains, to reſtore the parts to their former ſtate, without exciting any ſuch violent conflict. The good effects of vinegar, verjuice, ſpirit of wine, and other contracting liquids, in ſprains, are to be explained upon the ſame principles.

Tenthly, Hot or cold water feels hotter or colder, reſpectively, when the hand is moved in it, than when it is kept at reſt. For the hand, when at reſt, has time, a little to check or exalt the vibrations in the contiguous hot or cold water.

Eleventhly, When a perſon goes into cold water leiſurely, he is apt to ſob, and to reſpire in a convulſive manner, for a ſhort time. For the impreſſion of the cold upon the lower limbs excites ſuch vigorous vibrations in the abdominal, and other muſcles of expiration, as being nearer to the ſeat of the impreſſion than the muſcles of inſpiration, that a convulſive continued expiration is firſt produced, then a ſob, or deep inſpiration; and laſtly, ſtrong convulſive expirations and inſpirations for ſome ſucceſſions.

The good effects of cold bathing ariſe perhaps, in part, from its narrowing the ſphere of attraction in the ſmall parts of the muſcular fibres, and at the ſame time making this attraction ſtronger. Hence it may be prejudicial in ſome paralytical affections, as it is found to be. For, if the ſmall veſſels of the nerves be obſtructed, it may, by contracting the ſolids, increaſe the obſtruction, and, conſequently, the impediment to the free vibrations neceſſary to ſenſe and motion.

Twelfthly, Bathing in warm water, impregnated with active mineral particles, may, by exciting and increaſing vibrations in the white medullary ſubſtance, as well as by other means, remove obſtructions in its ſmall veſſels, and thus be ſerviceable in many paralytical diſorders, as it is found to be in fact. The ſame reaſoning is applicable to the ſtiffneſs, inſenſibility, and impotency, of motion, which the rheumatiſm often leaves in the limbs.

Cold bathing may in like manner be ſerviceable in paralytic and rheumatic diſorders, by exciting and increaſing vibrations; provided the ill effect from the immediate contraction does not preclude this good one.

Thirteenthly, Since frictions, and other impreſſions upon the ſkin, increaſe the vibrations there, it may be expected, that they ſhould increaſe the heat. And this is the fact. If a perſon rubs his hands together in cold weather, the ſenſation of heat will be felt to ariſe in a moment, and to go off again in a moment after he ceaſes to rub; for the vibrations excited by rubbing may be expected to languiſh immediately, if not kept up by continuing the friction.

Fourteenthly, Strong taſtes may, according to the doctrine of vibrations, be expected to leave a heat upon the tongue, mouth, and *fauces*, as they are found to do. And, in general, all vivid impreſſions upon every part of our bodies ought to increaſe the heat generally or particularly; which perhaps is the caſe, though we are ſeldom able to determine this by obſervation.

Fifteenthly, All ſtrong emotions of mind ought alſo to increaſe the heat of the body. This is a matter of common obſervation, if we except the chillineſs of the ſkin, and coldneſs of the extremities, which have been explained above, agreeably to the doctrine of vibrations.

The three laſt articles favour the above delivered conjectures concerning the peculiar nature of the vibrations belonging to heat. The phænomena enumerated in all the fifteen may admit of other explanations, at leaſt in part, but of none, as far as I can judge, that are inconſiſtent with the doctrine of vibrations.

PROP.

PROP. XXV.

To examine how far the Phænomena of Wounds, Burns, Bruiſes, Lacerations, Inflammations, and Ulcers, are agreeable to the Doctrine of Vibrations.

THE manifeſt ſolution of continuity, which is the very eſſence of a wound, may occaſion pain, agreeably to the doctrine of vibrations, in the manner that has been explained already. This is the immediate pain that attends a wound. The ſubſequent one is to be referred either to the head of inflammation, or to that of ulcer.

The immediate pain from burns has likewiſe been explained agreeably to the doctrine of vibrations, alſo the ſeparation of the dead or mortified eſchar, under the laſt propoſition. The ſubſequent pain is to be referred to the heads of inflammation and ulcer, as before.

A bruiſe is ſuppoſed, and with the appearance of reaſon, to be an infinite number of infinitely ſmall wounds. It ought therefore to be attended with a pain reſembling that of a large wound, and yet not exactly the ſame, which is the fact. As large wounds are ſometimes healed by the firſt intention, without any ſubſequent ulcer, ſo may bruiſes. If otherwiſe, the ſubſequent pain muſt again be referred to the heads of inflammation and ulcer.

Lacerations are great wounds attended with bruiſes, *i. e.* with an infinite number of infinitely ſmall ones. Theſe are never cured without coming to digeſtion, *i. e.* an ulcer, and the requiſite previous inflammation.

The heat and diſtention of the ſmall veſſels in inflammations are ſufficient to account for the pain attending them, upon principles already laid down.

In ulcers the nerves are expoſed defenceleſs, and therefore are ſuſceptible of the moſt violent vibrations, and conſequent pain from ſlight impreſſions; to which it is to be added, that the moiſture of ulcers, by diſſolving the ſaline parts of bodies applied, greatly augments their actions upon the naked nerves.

Fomentations and cataplaſms ſeem to afford relief in the foregoing caſes, partly by diffuſing an equal warmth all around, partly by their aqueous or oily moiſture. For the diffuſion of warmth prevents that conflict, which would ariſe between neighbouring parts of different heats; and the moiſture, which inſinuates itſelf among the ſmall particles, ſets them at greater diſtances, and conſequently leſſens their mutual actions. The violent vibrations will therefore be moderated on both accounts. The friction attending embrocations does in like-manner diffuſe vibrations all around, and the liniment or liquid, with which the embrocation is made, may contribute according to its particular qualities. Hence embrocations are alſo of uſe in reſolving obſtructions.

In all theſe caſes the violent vibrations, which aſcend along the nerves of the injured part, muſt be communicated in a particular manner to the neighbouring branches, and occaſion a ſlight inflammation, *i. e.* a ſoreneſs, there. This ſoreneſs is not perceived while the original inflammation ſubſiſts, being obſcured by it. The vibrations in the neighbouring nerves may alſo be increaſed by the ceſſation of violent ones in the place of original inflammation. Hence the ſoreneſs of the neighbouring parts after colics, head-achs, &c. The pain in the external parts of the head, which follows a debauch, *i. e.* an inflammation of the brain, and its membranes, may be of the ſame kind.

Theſe hints may ſerve to ſhew, that the doctrine of vibrations is as agreeable to the phænomena of wounds, burns, &c. as any other yet propoſed, or even more ſo. But much farther inquiry is requiſite.

PROP.

PROP. XXVI.

To examine how far the Phænomena of Itching and Titillation are agreeable to the Doctrine of Vibrations.

Itching often attends the beginning and ending of inflammations, and particularly the eruption of inflammatory puſtules. We may conclude therefore, according to the foregoing account of inflammations, that itching is cauſed by a moderate increaſe of vibrations, in a part of ſmall extent.

It is agreeable to this, that the lodgment of the perſpirable matter, or other cutaneous ſecretion, when hardened, occaſions itching; for it is eaſy to conceive, that, in theſe caſes, an obſtruction and ſlight inflammation in the ſmall veſſels of the ſkin may ariſe.

Preſſure, which allays itching, may be ſuppoſed to do this by checking the vibrations.

Scratching may convert it into a pleaſure, by communicating the increaſed vibrations to the neighbouring parts, in ſuch a degree as falls within the limits of pleaſure. And as this freer communication cauſed by ſcratching may increaſe the vibrations in the neighbouring parts, ſo it may leſſen thoſe which ſubſiſted before in the point that itched, thus reducing all to an equality, or nearly ſo. At the ſame time it appears, that rude or long-continued ſcratching muſt, by the increaſe of vibrations, which it occaſions, alſo by laceration, increaſe the heat, inflammation, and itching, and even end in pain.

Friction of the ſkin, without previous itching, excites a pleaſurable ſenſation; and alſo ends in inflammation and pain, when carried too far, for the like reaſons.

Since extreme parts are more apt to receive an increaſe of vibrations than others, as has been obſerved;

it appears, that the itching of the noſe and *anus* may be expected to attend worms in the ſtomach or inteſtines, and the itching of the *glans penis* and *anus* a ſlight inflammation at the neck of the bladder from a ſtone. Theſe inſtances ſhew, that vibrations run freely along the ſurfaces of uniform membranes; and this is farther confirmed in the laſt caſe, by the check which a preſſure made *in perinæo*, or any where upon the *urethra*, will give to the itching in the *glans*.

Titillation is nearly related to itching. It is excited by ſlight impreſſions upon the more ſenſible parts, frequently renewed; and this may ſhew, that it ariſes from an increaſe of vibrations. The impreſſions muſt be ſo ſlight as not to excite a contraction in the neighbouring muſcular fibrils, and alſo frequently renewed, that the increaſe of vibrations may diffuſe itſelf farther and farther perpetually; and thus the whole nervous ſyſtem may, in ſome caſes, be at laſt put into a pleaſurable ſtate, approaching to the limits of pain, and paſſing within them at times.

Hence it appears, that as ſoon as children have learnt to cry, or yield a ſound, from naſcent pains, and from pleaſures juſt paſſing into pains, titillation may excite ſhort, alternate, naſcent cries in them, *i. e.* laughter, but not before. If the impreſſions be made upon the cheſt, the effect will be quicker and ſtronger, becauſe theſe impreſſions have a direct influence upon the muſcles concerned in laughter.

If a feather be paſſed ſlightly to and fro between the lips, it will excite a titillation there, which will diffuſe itſelf into the neighbouring parts of the upper lip and chin, and paſs into an itching in them. The original titillation between the lips may be allayed by preſſing them together, and the conſequent itching by preſſure and friction, as in other caſes. All theſe things ſuit with the hypotheſis of vibrations, and of their free diffuſion.

In like manner, the free diffuſion of vibrations, and their influence in contracting the neighbouring muſcles, may be inferred from the vomitings, which are excited by tickling the *fauces* with a feather.

PROP. XXVII.

To examine how far the Senſations attending Preſſure, and muſcular Contraction, are agreeable to the Doctrine of Vibrations.

As friction and titillation agree with heat in increaſing vibrations, ſo preſſure agrees with cold in checking them. Thus preſſure abates the uneaſineſs from itching, as mentioned above; and binding, or otherwiſe gently compreſſing, parts in pain, or inflamed, *i. e.* parts in which the vibrations are exceſſive, will, for the moſt part, afford relief; whereas friction would increaſe the pain to a great degree. But the pain uſually becomes more violent the inſtant the compreſſion is removed. For the mere elaſticity of the parts alters their figure, *i. e.* produces internal motions, with an increaſe of vibrations. Preſſure may alſo increaſe vibrations in the internal parts, contiguous to thoſe where it checks them; or even in the external ones, if it be ſo great as to occaſion any conſiderable diſtention there. And thus there may be a variety of vibrations occaſioned by the ſeveral kinds and degrees of preſſure, ſufficient to correſpond to all the variety of ſenſations excited thereby.

Muſcular contraction moſt commonly attends and is attended by preſſure, as in the common motions of handling and walking, whereby we overcome the *vis inertiæ* of our own bodies, and of thoſe which we have occaſion to move or ſtop. Hence all the ſenſations, which we receive from the *vis inertiæ* of matter, muſt be derived from theſe two ſources of muſcular contraction and preſſure.

Now it has been obſerved already, that muſcular contraction checks the vibrations in the contracted fibres, and increaſes them in the neighbouring parts. And it is eaſy to conceive, that the ſenſation correſponding to this alteration of vibrations may ſometimes fall within the limits of pleaſure, ſometimes go beyond them. In young animals, alſo after ſleep and reſt, in all, it is uſually pleaſant; after much labour, or ſprains, and in inflammations, painful; and this, whether the diſordered muſcle itſelf, or its antagoniſt, be contracted. For there muſt be an increaſe of vibrations in the diſordered muſcle both before it can be itſelf contracted, and alſo in conſequence of the contraction of its antagoniſt; as has been ſhewn before.

PROP. XXVIII.

To examine how far the Phænomena of Numbneſſes, and paralytical Inſenſibilities, are agreeable to the Doctrine of Vibrations.

Numbness, being a diminution of ſenſibility, ought, according to the doctrine of vibrations, to proceed from ſuch cauſes, as either indiſpoſe the parts for the reception of vivid vibrations, or hinder their free aſcent to the brain. Agreeably to this, a compreſſion made upon the nerve, which leads to any part, will occaſion a numbneſs in that part, the nerve below the compreſſion being unfitted thereby to receive vibrations freely, and the nerve above incapable of tranſmitting freely ſuch as are excited. A compreſſion of a blood veſſel may have a like effect, becauſe it muſt leſſen that heat, and inteſtine motion, which a free circulation would communicate to the part. The compreſſion uſually made upon the ſkin, when we preſs a nerve or blood veſſel, will alſo contribute. And external cold will haſten the effect, when joined to the juſt named cauſes; or produce it alone, if intenſe, or long continued. In like manner, numbneſs, from a compreſſion made upon the nerves or blood veſſels, is much favoured by ſleep, becauſe the parts are then indiſpoſed both to receive and to tranſmit vibrations.

The benumbed limb feels larger, becauſe any groſs body, which encompaſſes and preſſes upon a limb by its weight or ſtricture, deadens the vibrations in it; and therefore converſely, when the vibrations are ſo deadened from a different cauſe, the idea of a groſs encompaſſing body, or, which is almoſt the ſame thing, of the enlargement of the limb, will be ſuggeſted to the mind. But this circumſtance muſt be referred to the head of aſſociation.

When the benumbed part begins to recover its feeling, violent prickings are often perceived. Now theſe ſeem to take place in the points where the natural vibrations firſt return, ſuppoſe at the ends of the nervous *papillæ*, and to ariſe from the conflict between the natural vibrations in theſe points, and the languid ones in the neighbouring parts. However, they come to an equality at laſt, by their mutual influences, as well as by the return of the natural vibrations to all the parts; which may ſerve to ſhew how itching ceaſes at laſt of itſelf. Friction helps to diſperſe and remove theſe prickings, and to reſtore the loſt ſenſibility, which is very ſuitable to the notion of vibrations, and to the effect which it has in itchings.

If the hand be held down, and ſhaken, its muſcles being firſt relaxed by a voluntary power, a numbneſs will be occaſioned, in which the fingers feel large, for the reaſon given above. This numbneſs ſeems to ariſe from the irregular agitations, or vibrations, excited in the ſmall parts; which, being different from the natural ones, or thoſe in which ſenſibility conſiſts, muſt check them; juſt as the agitations of water from the wind hinder the free propagation of regular undulations from a ſtone caſt into it; or as any commotion of the air checks the free and diſtinct communication of a ſound. It ſeems alſo, that thoſe irregular and diſſonant vibrations, which ſhaking the hand cauſes in the ſmall medullary particles of its nerves, may paſs on from part to part, though not ſo freely as regular ones.

From hence we may proceed to conſider the numbneſs occaſioned by the ſtroke of the *torpedo.* For the oſcillations of this fiſh's back may neither be iſochronous in themſelves, nor ſuitable to thoſe which exiſted previouſly in the hand; and yet they may be ſo ſtrong, as not only to check and overpower thoſe in the part which touches the fiſh, but alſo to propagate themſelves along the ſkin, and up the nerves, to the brachial ganglion, and even to the ſpinal marrow and brain; whence the perſon would firſt feel the ſtupefaction aſcend along the arm to the ſhoulder, and then fall into a giddineſs, and general confuſion, as is affirmed to happen ſometimes. Some effects of concuſſions of the brain, and perhaps of the ſpinal marrow, alſo of being toſſed in a ſhip, of riding backwards in a coach, and of other violent and unuſual agitations of the body, ſeem to bear a relation to the preſent ſubject. But it would be too minute to purſue theſe things.

When a palſy ariſes from an internal cauſe, we may ſuppoſe, that the medullary part of the brain, or of the ſpinal marrow, or the nerve itſelf, in all which the veſſels are extremely fine, and therefore liable to obſtructions, eſpecially in old age, become opaque, and unqualified to receive and tranſmit vibrations freely, according to Sir *Iſaac Newton*'s opinion. Hence a diminution or entire loſs of ſenſe or motion, or both, may follow, according to the degree and extent of the obſtruction and opacity. The voluntary power of motion is ſoon loſt, as being an acquired faculty, and depending upon aſſociated circumſtances, and memory. But if there be any degree of inflammation in the fine veſſels of the motory nerves, or of the correſponding parts of the brain, this may occaſion convulſive motions; and for the ſame reaſon, an inflammation in the ſenſory nerves, or their origins in the brain, may occaſion pain. Now it is reaſonable to expect ſuch inflammations in many caſes as a conſequence of the obſtructions, and both convulſive motions and pains are often found to attend paralytic affections.

PROP. XXIX.

To examine how far the Phænomena attending on venomous Bites and Stings are agreeable to the Doctrine of Vibrations.

THAT the active liquors, infuſed by venomous animals after they bite or ſting, operate, in part, by the violent vibrations which they excite in the living parts immediately affected, and which are thence propagated along the nerves up to the brain, and alſo along the ſurface of the body, by means of the continuity and uniformity of the ſkin, may appear from the following reaſons.

Firſt, As the ſolids and fluids, ſeem in general, equally concerned in all the natural functions, and morbid deviations from them, it is moſt reaſonable to refer part of the effects of venomous bites and ſtings to each. But it is difficult to conceive how theſe poiſons ſhould have any immediate effect upon the ſolid nervous capillaments, but by agitating their parts.

Secondly, The active particles of theſe poiſons, which are able, in ſo ſmall a quantity, to produce ſuch violent diſorders, and ſometimes in a very ſhort ſpace of time, may well be conceived able alſo to agitate the nervous parts with ſtrong vibrations.

Thirdly, If we ſuppoſe their firſt and moſt immediate effect to be upon the fluids, yet this may, or muſt, be agitations, that will afterwards be communicated to the ſolids.

Fourthly, The vibrations of the medullary particles, mentioned in this theory, ſeem peculiarly ſuited to anſwer the ſeveral quick and ſurprizing effects of theſe poiſons. The pain, ſwelling, redneſs, and lividneſs, all around the part affected, may eaſily be derived from the vibrations propagated all around. Oils and fats, rubbed upon the part, may, by damping theſe, prevent the ill effects. Vibrations propagated either along the ſkin, through the mouth and noſe, or up to the brain, and thence along the eighth pair of nerves, or, which is moſt probable, both ways, to that very ſenſible part the ſtomach, may produce ſickneſs and vomitings. And if the gall-duct be contracted from the ſame cauſe during the vomitings, a ſudden jaundice will follow from the violence with which the gall is forced back into the blood by the action of vomiting. Joy, ſorrow, fear, melancholy, may eaſily follow according to the reſpective natures of the poiſons, becauſe theſe, according to this theory, all ariſe from and are attended by correſponding vibrations in the white medullary ſubſtance of the brain. And a like account may be given of the averſion to black, and the delight in glaring objects, and ſtrong colours. The correſponding nerves of different animals have probably a general reſemblance to each other, juſt as the correſponding *viſcera* and fluids have. And thus the poiſon of rabid animals may have a peculiar power of affecting the nerves of the *fauces*, and muſcles of deglutition, ſo as to produce the *hydrophobia*. Cold bathing alſo, and muſic, whoſe immediate effects ſeem confined to the ſolids, to the exciting vibrations in them, may cure reſpectively in the bite of a mad dog, and of the tarantula.

However, what is here alleged is not at all to be ſo underſtood, as if the immediate effects of poiſons upon the fluids were not alſo very conſiderable. In ſome caſes they may be greater, in others, leſs than thoſe exerted upon the ſolids. It ſeems probable, that the poiſon is communicated from the fluids immediately affected to thoſe at a diſtance, chiefly by means of the ſerous veſſels. For theſe, having numerous immediate communications with each other, will tranſmit it freely, and yet ſo as that all the neighbouring parts may be affected ſomewhat in proportion to their nearneſs to the ſeat of the injury, as they are found in fact to be; whereas, were the diffuſion of the poiſon to be made by the circulation of the fluids alone, all the parts would have an equal chance. But the propagation of the poiſon along the ſolid capillaments of the nerves is alſo a principal reaſon why the neighbouring parts are more affected than the diſtant ones. The effects of inoculation bear a great reſemblance to thoſe of venomous bites and ſtings; and the ſame may be ſaid of venereal and other infections.

PROP. XXX.

To examine how far the tangible Qualities of Bodies admit of an Explanation agreeable to the Doctrine of Vibrations.

Hitherto we have conſidered only the more vigorous ſenſations of feeling, ſuch as may be called the pleaſures and pains of this ſenſe. We come now to the feeble and adiaphorous ſenſations. Theſe are moiſture, dryneſs, ſoftneſs, with fluidity, hardneſs, ſmoothneſs, roughneſs, motion, reſt, diſtance, and figure. Now it ſeems very eaſy to conceive, that theſe, with their ſeveral varieties, may impreſs correſponding varieties of vibrations upon the nerves of feeling; alſo, that theſe laſt varieties will be chiefly compoſitions of the vibrations ariſing from preſſure, and muſcular contraction, *i. e.* from the *vis inertiæ* of matter.

Thus, ſince moiſt bodies adhere to the fingers, and ſo leave a ſmoothneſs with their own degree of cold or heat upon them, moiſture may be judged of by the touch from this peculiar alteration of vibrations; and dryneſs from the abſence of it. Liquid bodies make no alteration of figure in our fingers, and yield eaſily to their motions: ſoft ones do the ſame in a leſs degree; hard ones the contrary. Smooth bodies make an equable preſſure, and give no reſiſtance to a motion along their ſurfaces; rough ones the contrary. The motions of our own bodies are attended by the vibrations peculiar to preſſure, and muſcular contraction; of other bodies, which touch our own, by thoſe from preſſure. We judge of reſt by the abſence of theſe. Diſtance is judged of by the quantity of motion, and figure by the relative quantity of diſtance. And thus it appears, that all degrees and kinds of theſe tangible qualities may impreſs correſponding vibrations upon thoſe regions of white medullary ſubſtance of the brain, and ſpinal marrow, which correſpond to the ſkin and muſcles.

The ſame qualities are made alſo by means of light to impreſs vibrations upon our eyes, which correſpond in great meaſure to thoſe made on the ſenſe of feeling, ſo as to vary with their varieties. And as the ſenſe of ſight is much more extenſive and expedite than feeling, we judge of tangible qualities chiefly by ſight; which therefore may be conſidered, agreeably to Biſhop *Berkley*'s remark, as a philoſophical language for the ideas of feeling; being, for the moſt part, an adequate repreſentative of them, and a language common to all mankind, and in which they all agree very nearly, after a moderate degree of experience.

However, if the informations from touch and ſight diſagree at any time, we are always to depend upon touch, as that which, according to the uſual ways of ſpeaking on theſe ſubjects, is the true repreſentation of the eſſential properties, *i. e.* as the earneſt and preſage what other tangible impreſſions the body under conſideration will make upon our feeling in other circumſtances; alſo what changes it will produce in other bodies; of which again we are to determine by our feeling, if the viſual language ſhould not happen to correſpond to it exactly. And it is from this difference that we call the touch the reality, light the repreſentative: alſo that a perſon born blind may foretel with certainty, from his preſent tangible impreſſions, what others would follow upon varying the circumſtances; whereas if we could ſuppoſe a perſon to be born without feeling, and to arrive at man's eſtate, he could not from his preſent viſible impreſſions judge what others would follow upon varying the circumſtances. Thus the picture of a knife, drawn ſo well as to deceive his eye, would not when applied to another body, produce the ſame change of viſible impreſſions, as a real knife does, when it ſeparates the parts of the body through which it paſſes. But the touch is not liable to theſe deceptions. As it is therefore the fundamental ſource of information in reſpect of the eſſential properties of matter, it may be conſidered as our firſt and principal key to the knowledge of the external world.

PROP. XXXI.

To explain in what Manner we are enabled to judge of the Seat of Impreſſions made on the external Surface of our Bodies.

When we apply the parts of our bodies to each other, particularly our hands to the ſeveral parts of the ſurface of our bodies, we excite vibrations in both parts, viz. both in the hands, and in that part of the ſurface which we touch. Suppoſe the hand to paſs over the ſurface gradually, and the firſt impreſſion will remain the ſame, while the laſt alters perpetually, becauſe the vibrations belonging to the laſt are excited in different nerves, and by conſequence enter the brain, or ſpinal marrow, at different parts. And this difference in the laſt impreſſion, or its vibrations, correſponding always to the part on which the impreſſion is made, will at laſt enable us to determine immediately what part of our bodies we touch; *i. e.* what is the diſtance of the part touched from the mouth, noſe, ſhoulder, elbow, or other remarkable part, conſidered as a fixed point.

For by paſſing frequently from the mouth, noſe, &c. to the part under conſideration, children learn this very early, even without attending to it at all explicitly.

Sight alſo helps us to judge of this diſtance in the parts, which are frequently expoſed to view, and this in proportion to that frequency.

Let us ſuppoſe then, that we are able to determine at once what external part of our bodies we touch, *i. e.* to determine how it is ſituated in reſpect of the other parts, and to ſhew the correſponding part in the body of another perſon; it will follow, that if a like impreſſion be made not by our own hand, but by that of another, or by any foreign body, we ſhall know at once the part on which it is made. We ſhall alſo, ſuppoſing us arrived at a ſufficient degree of voluntary power over the muſcles, be able at once to put our hand upon the part on which the impreſſion is made.

By degrees we ſhall learn to diſtinguiſh the part, not only when an impreſſion like the gentle ones of our hands is made upon it, but alſo when a vivid, rude, or painful one is. For, firſt, all impreſſions made upon the ſame part agree in this, whatever be their differences as to kind and degree, that they enter by the ſame nerves, and at the ſame part of the brain, and ſpinal marrow. Secondly, we impreſs a great variety of ſenſations ourſelves by our hands, according as they are hot or cold, by friction, ſcratching, &c. and moſt impreſſions from foreign bodies will bear ſome reſemblance to ſome of theſe. Thirdly, we often ſee upon what part impreſſions from foreign bodies are made. Fourthly, when they leave permanent effects, as in wounds, burns, &c. we always examine by feeling, where the impreſſion was made.

Now from all theſe things laid together it follows, that in itchings from an internal cauſe, and in impreſſions where neither our hand nor eye give us any information, we ſhall, however, be able to determine at once with tolerable accuracy what external part is affected, and to put our hand upon it, ſo as to confirm our preſent judgment, and render our future judgment, and voluntary power, more certain and ready. We ſhall alſo do this moſt readily in thoſe parts which we ſee and feel moſt frequently, the hands for inſtance; leſs ſo, *cæteris paribus*, in thoſe we ſeldom ſee or feel; and leaſt ſo, where we never ſee the part, and ſeldom touch it. At leaſt this ſeems to reſult from the theory. But it is to be obſerved, that the fact ought to be tried chiefly in children. For in adults the ſeveral degrees approach more to perfection, *i. e.* to an equality among themſelves.

PROP. XXXII.

To explain in what Manner, and to what Degree, we are enabled to judge of the Seat of internal Pains.

Here we may obſerve, firſt, that as we never ſee or feel the internal parts, ſuch as the lungs, heart, ſtomach, inteſtines, liver, kidneys, bladder, &c. we can have no direct information in the manner explained under the foregoing propoſition.

Secondly, Since all pains diffuſe an increaſe of vibrations into the neighbouring parts, the increaſed vibrations in the external parts, ariſing from internal pains, will be a groſs general direction, ſo as to determine the ſeat of the pain within groſs limits, in reſpect of ſuperior and inferior, anterior and poſterior, right and left.

Thirdly, Preſſing the external parts, ſo as to augment or alleviate the internal pain, muſt contribute alſo.

Fourthly, Since all the internal parts in the *thorax* and *abdomen* receive branches from the intercoſtal nerve, which communicates with each vertebral pair, it follows that the internal pains will ſend vibrations up to the ſpinal marrow, which will enter in at the ſame parts of it, as the vibrations from external pains in the neighbourhood. At the ſame time it appears from the many ganglions, plexuſes, and communications of nerves in the *thorax* and *abdomen*, alſo from the origin and diſtribution of the nerves of the *cauda equina*, that this can be no more than a groſs general direction; and that the great number of ſympathetic influences from theſe cauſes, alſo from the running of vibrations along membranes, and from their fixing particularly in nervous parts, or extreme ones, will give occaſion to many deceptions here, and in certain caſes make the pain be felt, *i. e.* appear to be, in parts at a conſiderable diſtance from the ſeat of the diſorder.

Fifthly, Suppoſe the patient to ſhew by the external parts whereabouts his pain is felt internally, then the phyſician may, from his knowledge of the ſituation of the internal parts in reſpect of the external, gueſs pretty nearly, what internal part is affected.

Sixthly, The ſymptoms attending the pain, its cauſe and conſequences, compared with the natural functions of the parts, with the hiſtory of diſeaſes, and morbid diſſections, will enable the phyſician to determine with great preciſion in ſome caſes, and help a little in moſt.

Seventhly, When the patient has had long experience of the ſame kind of internal pains, or of different ones, he deſcribes more exactly, and alſo gets certain fixed points, to which he refers his pains.

Eighthly, Anatomiſts and phyſicians may ſometimes judge with great exactneſs in their own caſes, having both a knowledge of the parts, and their functions, and alſo their own feelings, to guide them.

This ſubject deſerves a particular and accurate examination, it being of great conſequence to be able to diſcover the ſeat and *cauſa proxima* of the diſtemper, from the complaints of the patient, and from the previous concomitant, and conſequent circumſtances. I hope theſe two propoſitions may caſt ſome light upon it.

Here we may add an obſervation deducible from the doctrine of aſſociation, viz. as we learn by degrees, from impreſſions made on the ſurfaces of our bodies, to attend particularly to the ſenſations impreſſed on, or exiſting in each part, at pleaſure, *i. e.* to magnify the vibrations which take place in it; ſo, after diſorders in the internal parts, the aſſociated circumſtances ſeem often to renew the painful vibrations there, and to occaſion either the return of the like diſorder, or ſome other; at leaſt to have a conſiderable ſhare in theſe effects, when produced by their cauſes in an inferior degree. Thus diſorders in the bowels, cauſed at firſt by acrid impreſſions, lay the foundation for a return of like diſorders on leſs occaſions. Thus women that have often miſcarried, ſeem to irritate the muſcular fibres of the *uterus* by the recollection of the aſſociated circumſtances, and ſo to diſpoſe themſelves to miſcarry more than according to the mere bodily tendency; fear and concern having alſo a great influence here. All this will be farther illuſtrated by what follows under the next propoſition.

PROP.

PROP. XXXIII.

To explain in what Manner, and to what Degree, the Pleaſures and Pains of Feeling contribute, according to the Doctrine of Aſſociation, to the Formation of our intellectual Pleaſures and Pains.

It follows from the foregoing account of the power of leaving traces, and of aſſociation, that all the pains from intenſe heat and cold, wounds, inflammations, &c. will leave a diſpoſition in the nervous ſyſtem to run into miniature vibrations of the ſame kind, and that theſe miniature vibrations will be excited chiefly by the aſſociated circumſtances. That is to ſay, The appearance of the fire, or of a knife, eſpecially in circumſtances like to thoſe in which the child was burnt or cut, will raiſe up in the child's nervous ſyſtem painful vibrations of the ſame kind with, but leſs in degree than, thoſe which the actual burn or wound occaſioned.

By degrees theſe miniature pains will be transferred upon the words, and other ſymbols, which denote theſe and ſuch-like objects and circumſtances: however, as the diffuſion is greater, the pain transferred from a ſingle cauſe muſt become leſs. But then, ſince a great variety of particular miniatures are transferred upon each word, ſince alſo the words expreſſing the ſeveral pains of feeling affect each other by various aſſociations, and each of them transfers a miniature of its own miniature upon more general words, &c. it comes to paſs at laſt, that the various verbal and other ſymbols of the pains of feeling, alſo of other pains bodily and mental, excite a compound vibration formed from a variety of miniatures, which exceeds ordinary actual pains in ſtrength. Theſe compound vibrations will alſo have a general reſemblance, and particular differences in reſpect of each other.

It follows therefore *a priori*, as one may ſay, and by a ſynthetic kind of demonſtration, that, admitting the powers of leaving traces, and of aſſociation, compound or mental pains will ariſe from ſimple bodily ones by means of words, ſymbols, and aſſociated circumſtances. And they ſeem to me to anſwer in kind and degree to the facts in general. If, farther, we admit the doctrine of vibrations, then theſe compound mental pains will ariſe from, or be attended by, violent vibrations in the nervous ſyſtem, and particularly in the brain.

Agreeably to this account, we may obſerve, that the mere words denoting bodily pains, though not formed into propoſitions or threatenings, affect children. However, ſince there happen daily aſſociations of the mere words with freedom and ſecurity, and of propoſitions and threatenings with ſufferings, children learn by degrees to confine their fear, ſorrow, &c. to thoſe things which are eſteemed the genuine ſigns, reaſons, cauſes, &c. of ſufferings. This is the caſe in general; but there are great particular differences both in children and adults; which yet, if accurately purſued, would probably not only be conſiſtent with, but even confirm and illuſtrate, the doctrine of aſſociation.

And we may conclude upon the whole, ſince the pains of feeling are far more numerous and violent than thoſe of all the other ſenſes put together, that the greateſt part of our intellectual pains are deducible from them.

In like manner the pleaſures of an agreeable warmth, and refreſhing coolneſs, when we are cold or hot reſpectively, of gentle friction and titillation, leave traces of themſelves, which by aſſociation are made to depend upon words, and other ſymbols. But theſe pleaſures, being faint and rare in compariſon of others, particularly of thoſe of taſte, have but a ſmall ſhare in forming the intellectual pleaſures. Titillation may perhaps be excepted. For laughter, which ariſes from it, is a principal pleaſure in young children, and a principal ſource of the other pleaſures, particularly of thoſe of ſociality, and benevolence. Farther, ſince the miniatures left by the pains of feeling muſt in ſome caſes be faint originally, in others decline from the diffuſion, the faintneſs of the aſſociation, &c. theſe miniature pains will often fall within the limits of pleaſure, and conſequently become ſources of intellectual pleaſure; as in recollecting certain pains, in ſeeing battles, ſtorms, wild beaſts, or their pictures, or reading deſcriptions of them.

PROP. XXXIV.

To give an Account of the Ideas generated by tangible Impreſſions.

HERE it may be obſerved, firſt, that the very words, *burn*, *wound*, &c. ſeem even in adults, though not formed into propoſitions, or heightened by a conjunction of circumſtances, to excite, for the moſt part, a perception of the diſagreeable kind; however, ſo faint in degree, that it may be reckoned amongſt the number of ideas, agreeably to the definitions given in the introduction.

Secondly, The words expreſſing the pleaſures of this ſenſe are probably attended with perceptions, though ſtill fainter in degree. Theſe perceptions may therefore be called the ideas belonging to thoſe words.

Thirdly, the words *moiſt*, *dry*, *ſoft*, *hard*, *ſmooth*, *rough*, can ſcarce be attended with any diſtinguiſhable vibrations in the fingers, or parts of the brain correſponding thereto, on account of the faintneſs of the original impreſſions, and the great varieties of them; however, analogy leads us to think, that ſomething of this kind muſt happen in a low degree. But when the qualities themſelves are felt, and the appropriated vibrations raiſed, they lead by aſſociation to the words expreſſing them; and thus we can diſtinguiſh the ſeveral tangible qualities from each other by the differences of their vibrations, and declare in words what each is.

Fourthly, The vibrations excited in the ſenſe of feeling by motion, diſtance, and figure, are ſo faint, and ſo various, that neither theſe words, nor any related expreſſions, can be ſuppoſed to excite any miniature vibrations in this ſenſe. Yet ſtill, upon feeling motions and figures, and paſſing over diſtances, the differences of vibrations from preſſure and muſcular contraction, *i. e.* from the *vis inertiæ* of our own bodies, or of foreign matter, ſuggeſt to us the words expreſſing theſe, with their varieties, by aſſociation.

Fifthly, The great extent of the ſenſe of feeling tends to make the miniatures fainter, eſpecially as far as the external parts are concerned; and would probably have ſo powerful an effect upon the miniatures raiſed in the internal parts, as to make them by oppoſing deſtroy one another, did not all the impreſſions of the ſame nature, viz. all thoſe from heat, from cold, from friction, &c. by whatever external part they enter, produce nearly the ſame effect upon the brain. Whence the ſeveral miniatures left by particular impreſſions of the ſame kind muſt ſtrengthen one another in the internal parts, at the ſame time that they obliterate one another in the external ones. However, where a perſon has ſuffered much by a particular wound, ulcer, &c. it ſeems according to the theory, that an idea of it ſhould be left in the part affected, or correſponding region of the brain, or ſpinal marrow.

Sixthly, The viſible ideas of the bodies which impreſs the ſeveral ſenſations of feeling upon us, are, like all other viſible ones, ſo vivid and definite, that they mix themſelves with, and ſomewhat obſcure, the moſt vivid ideas of feeling, and quite overpower the faint ones. Sight communicates to us at once the ſize, ſhape, and colour of objects; feeling cannot do the laſt at all, and the two firſt only in a tedious way; and is ſcarce ever employed for that purpoſe by thoſe who ſee. Hence perſons born blind muſt have far more vivid and definite ideas of feeling than others. An inquiry into their real experiences would greatly contribute to correct, illuſtrate, and improve, the theory of ideas, and their aſſociations.

PROP. XXXV.

To explain the automatic Motions, which ariſe from tangible Impreſſions.

The principal of theſe is the action of crying, which is in all animals, but eſpecially young ones, the natural and neceſſary conſequence of pain. I have already given ſome account of this action; but will here enter into a more particular detail of the circumſtances, and their agreement with the foregoing theory.

Let us ſuppoſe then a young child to have a very painful impreſſion made upon the ſkin, as by a burn. It is plain that the violent vibrations excited in the injured part, will paſs up to the brain, and over the whole muſcular ſyſtem, immediately; putting all the muſcles into a ſtate of contraction, as much as may be, *i. e.* making the ſtrongeſt ſet of muſcles every where overpower the weaker, for a certain time, and then give place to them for a certain other time, and ſo on alternately. Since therefore the muſcles of expiration are ſtronger than thoſe of inſpiration, the air will be forced ſtrongly out of the *thorax* through the *larynx*, and, by conſequence, yield a ſound. It contributes to this, that the muſcles of the *os hyoides* and *larynx*, acting all together, and drawing different ways, muſt ſuſpend the cartilages of the *larynx*, ſo as both to narrow the paſſage of the air, and alſo render theſe cartilages more ſuſceptible of vibrations. As to the muſcles which contract and dilate the *larynx*, they are perhaps about equal in ſtrength to each other, and therefore may, by oppoſing each other, keep the chink in a ſtate intermediate between its leaſt and greateſt dilatation.

That the ſtrongeſt ſet of antagoniſt muſcles overpower the weaker, during the great effort in crying, may farther appear from the action of the extenſors of the neck, and flexors of the hand (both which ſets are ſtronger than their antagoniſts), at that time.

If it be objected here, that the elevators of the lower jaw, being ſtronger than the depreſſors, ought to keep the mouth ſhut during the action of crying, according to the foregoing reaſoning, whereas the contrary alway happens; I anſwer, firſt, that when both theſe ſets of muſcles act at the ſame time, in proportion to their natural ſtrength, the mouth ought to be a little opened; ſecondly, that the vibrations which take place in the cartilages of the *larynx* ſeem to impart a peculiar degree of force to all the neighbouring muſcles, *i. e.* to the depreſſors of the lower jaw; and, thirdly, that the muſcles which paſs from the *larynx* and *os hyoides* to the lower jaw act to an advantage in drawing it down, in the preſent caſe, becauſe the *os hyoides* is at this time fixed by its other muſcles.

The diſtortions of the face, which happen previouſly to crying, and during the courſe of it, ſeem to be ſufficiently agreeable to the notions here advanced; the muſcles, which draw the lips from each other, being much ſtronger, than thoſe which cloſe them.

The manner in which titillation occaſions laughter in its automatic ſtate, has been already explained. We may add here, that touching the cheeks of young children gently will excite ſmiling.

Friction alſo occaſions many automatic motions in young children, as may be obſerved when their naked bodies, or hairy ſcalps, are rubbed by the nurſe's hand; the motion being determined in theſe caſes, as appears, by the ſtrength and vicinity of the muſcles.

The contraction of the hand in young children, which has been taken notice of already, may be excited by titillation, friction, and almoſt any impreſſion on the palm; and is to be deduced partly from the ſuperior ſtrength of the flexors here, partly from the exquiſite ſenſibility of the palm. The contraction of the foot from impreſſions made on the ſole is analogous to that of the hand.

It may not perhaps be amiſs to add here, that the cellular ſubſtance intervenes leſs between the ſkin and ſubjacent muſcles in the ſcalp, palm, and ſole, than in other parts, as appears both from anatomical inſpection and emphyſemas; and that this may increaſe the influence of the impreſſions on theſe parts over the ſubjacent muſcles.

PROP. XXXVI.

To explain the Manner, in which the automatic Motions, mentioned in the laſt Propoſition, are converted into voluntary and ſemivoluntary ones.

THIS has been done, in ſome meaſure, already, in reſpect of the actions of crying, and contracting the hand, and their derivatives, ſpeaking and handling; and will be done more completely hereafter in a propoſition appropriated to the diſtinct conſideration of the motions that are perfectly voluntary. I have therefore inſerted the preſent propoſition chiefly for the ſake of regularity, and that the reader might have in one ſhort view, from the propoſitions of this ſection, all the principal heads of inquiry relating to the ſenſe of feeling.

It may not, however, be improper here to obſerve, that the great variety of frictions, flexures, and poſitions, which nurſes give to young children, make a proportional variety of combinations of muſcles which act together; and that theſe, by oppoſing the natural ones from juxtapoſition, derivation of nerves, &c. to a certain degree, prepare the way for ſuch voluntary combinations, as are requiſite in the future incidents of life.

SECT.

SECT. II.

OF THE SENSE OF TASTE.

PROP. XXXVII.

To aſſign the Extent of the Organ of Taſte, and to explain, in general, the different Powers lodged in the different Parts of it.

THE taſte may be diſtinguiſhed into two kinds, as before obſerved of feeling, viz. the particular exquiſite one, which reſides in the tongue, and eſpecially in the tip of it; and the general one, which extends itſelf to the inſides of the lips and cheeks, to the palate, *fauces*, *oeſophagus*, ſtomach, and whole alimentary duct, quite down to the *anus*; the ſenſibility growing perhaps leſs and leſs, perpetually, in going from the ſtomach to the *rectum*. The ſenſibility of the alimentary duct is probably of the ſame kind with, and not much greater in degree than, that of the internal ſurfaces of the gall-bladder, urinary-bladder, *pelvis*, ureters, and, in general, of the ſecretory and excretory veſſels, and of the receptacles belonging to the glands. But I refer the ſenſations of this duct to the taſte, on account of their connection with thoſe of the tongue, in reſpect of their cauſes, uſes, and effects.

As to the particular and ſuperior powers of the tongue, they may, in part, be deduced from the number and largeneſs of its *papillæ*, and from their riſing above the ſurface in living perſons more remarkably than any other ſentient *papillæ* in the whole body, ſo as to be extreme parts in an eminent degree. To which we ought perhaps to add, that the tip and ſides, in which the taſte is moſt exquiſite, are alſo extreme parts. But there may be likewiſe a different peculiar diſtribution, and other cauſes of an exquiſite ſenſibility, in the nerves of the tongue.

It deſerves notice here, that the friction of the tongue againſt the palate is neceſſary, in order to excite the taſtes of the aliments, which we maſticate, in perfection. This practice is analogous to that of rubbing the ends of the fingers upon ſuch bodies as we examine accurately by feeling; and both appear ſuitable to the notion of vibrations; alſo to that of the diſtention and erection of the ſentient *papillæ*: which may even be ſeen in the *papillæ* of the tongue.

It has been obſerved, that bitters and acids applied to funguſes of the brain, and even to iſſues upon the *vertex*, have ſometimes occaſioned the ſenſations of the taſtes reſpectively ariſing from the ſame bitters and acids, when applied to the tongue. This may perhaps be ſolved by ſuppoſing, that the bitters and acids, when applied to the nerves of the fifth pair, in the funguſes of the brain, and to thoſe of the ſeventh, or perhaps of the fifth alſo, in the iſſues (for the fifth pair may tranſmit ſome branches to the external integuments from the *dura mater*, at the *vertex*), ſend up their own ſpecific vibrations into thoſe regions of the brain, which are the peculiar reſidence of taſtes, *i. e.* to the regions which correſpond to the fifth pair, according to ſome anatomiſts. And theſe ſenſations may even afford ſome evidence, that the fifth pair, not the ninth, ſupplies the tongue with ſenſory nerves.

PROP. XXXVIII.

To examine how far the Phænomena of Taſtes, and their ſpecific Differences, are ſuitable to the Doctrine of Vibrations.

Here I obſerve, firſt, that heating any ſapid liquid increaſes its taſte, eſpecially if it be of the bitter, ſpirituous, or acrid kind; and, converſely, that the impreſſion of ſuch taſtes generates a heat in the organ, which remains after the peculiar taſte ceaſes. Now this connection of certain taſtes with heat is ſome preſumption, that they ariſe from vibrations, provided we allow heat to ariſe from them, according to the common opinion.

Secondly, Since diſagreeable taſtes muſt, according to the account of pain given above, ariſe from ſuch a violence in the vibrations excited, as produce the ſolution of continuity, and pleaſant taſtes, from more moderate degrees of vibrations, which, though they approach to the ſolution of continuity, yet fall ſhort of it; the pains of taſte muſt proceed from ſtronger vibrations than the pleaſures. And, agreeably to this, bodies which impreſs very active and diſagreeable taſtes, manifeſt great activity in other trials, for the moſt part.

Thirdly, It is very difficult to give any plauſible account of the great variety of pleaſant and unpleaſant taſtes from the doctrine of vibrations. However, the different frequency of vibrations, which belongs to the ſmall particles of different ſapid bodies, may be, in a good meaſure, the ſource of this great variety. For if the particles of the body *A* oſcillate twice, while thoſe of the body *B* oſcillate only once, the ſenſations excited by them may be different, though both fall within the limits of pleaſure, or both paſs into thoſe of pain. The differences of degree may alſo contribute; for it is obſervable, that different diſagreeable taſtes, in declining, leave agreeable ones, which approach to each other. This I have experienced in aloes, lime, and green tea not ſweetened. It may therefore be, that the different diſagreeable taſtes were ſuch rather on account of degree than kind. And, upon the whole, it may be, that the ſeveral combinations of the differences of kind with thoſe of degree may be ſufficient in number to account for all the varieties and ſpecific differences of taſtes.

Fourthly, Taſtes appear to be more different than they are from the odours which accompany ſome of them. And this obſervation, by reducing the number of taſtes properly ſo called, does ſomewhat leſſen the difficulty of accounting for their number. But then it is alſo to be obſerved, that part of this difficulty is to be transferred to the head of odours.

Fifthly, the power of diſtinguiſhing taſtes ſeems to depend upon ſight, to a certain degree. And this conſideration alſo leſſens the number of taſtes properly ſo called.

Sixthly, If we ſuppoſe the ſapid body to conſiſt of particles, that excite vibrations of different frequencies, which may be the caſe of many bodies in their natural ſtate, and probably muſt be with ſuch as are compounded by art, compound medicines for inſtance, a great variety of taſtes may ariſe, ſome reſembling the taſtes of ſimple bodies, others totally unlike theſe; juſt as ſome of the colours reflected by natural and artificial bodies reſemble one or other of the ſimple primary ones, whilſt others are colours that can ſcarce be referred to any of theſe. And we may farther ſuppoſe, in both caſes, that where the vibrations approach ſo near, in frequency as to over-rule each other, and produce one ſpecies only, there reſults a taſte, or a colour, that reſembles a primary one; whereas, if the vibrations differ ſo much in frequency,

quency, as that two or more principal ſpecieſes keep their own frequency, the taſte, or colour, generated from them, cannot be likened to any primary one.

Seventhly, That there are different ſpecieſes of vibrations, which yet all conſtitute ſweet or bitter, I conjecture not only from the foregoing general reaſoning, but alſo becauſe there are both ſweets and bitters in all the three kingdoms, animal, vegetable, and mineral. Thus milk, ſugar, and *ſaccharum ſaturni*, all yield a ſweet taſte; gall, aloes, and cryſtals of ſilver, all a bitter one.

Eighthly, Some differences of taſte may ariſe from the different time required for the ſolution, and conſequent activity, of the ſapid particles, alſo from the different local effect which they may have upon the *papillæ*, when abſorbed by their venous veſſels, &c.

Ninthly, Very nauſeous and ſtupefacient taſtes may perhaps ariſe from violent and irregular vibrations, and bear ſome analogy to the ſenſation, or want of it, impreſſed by the ſtroke of the *torpedo*.

Tenthly, It ſeems to deſerve particular conſideration here, that milk, and the fleſh of certain domeſtic animals, yield taſtes, which are naturally and originally pleaſant, to a conſiderable degree, and yet not in exceſs, as ſugar, and other very ſweet bodies, are. For it is reaſonable to conclude, that the particles of milk, and common fleſh-meats, muſt agree very much in the ſtrength and frequency of vibrations with the particles of our own ſolids and fluids. They may therefore juſt moderately increaſe the natural vibrations of the organ, when applied thereto, and enforced by ſuction, maſtication, and friction of the tongue againſt the palate. For the ſame reaſons we may gueſs, that the common diet of animals does not undergo very great changes, in reſpect of the vibratory motions of its particles, from its circulation, and conſequent aſſimilation. However, there are ſome eminent inſtances to the contrary, eſpecially in poiſons. Theſe laſt obſervations may be extended to vegetables, ſalutary and poiſonous, reſpectively.

Eleventhly, Some acrid taſtes, that of muſtard for inſtance, affect the tip of the *uvula*, and the edge of the ſoft palate, in a particular manner. Now this may a little confirm the conjectures above made concerning the ſenſibility and irritability of extreme parts.

Twelfthly, it is eaſy to conceive, upon the principles of theſe papers, how ſweets and bitters of an inferior degree ſhould render thoſe of a ſuperior one leſs affecting, reſpectively, as they are found to do.

The foregoing articles are only imperfect conjectures, and do not even approach to a ſatisfactory ſolution. They may juſt ſerve to ſhew, that the doctrine of vibrations is as ſuitable to the phænomena of taſtes, as any other hypotheſis yet propoſed. The following methods may perhaps be of ſome uſe for the analyſis of taſtes.

Firſt, To make trials upon bodies whoſe particles ſeem ſimilar to each other. Such are perhaps diſtilled ſpirits, acid, alkaline, and fermented; alſo ſalts, and oils; but they muſt all be ſufficiently purified by repeated diſtillations, ſolutions, and ſuch-like chemical operations; elſe we are ſure, that their component particles are heterogeneous.

Secondly, To note the changes of taſte in chemical operations, and compare them with the changes of colour; which laſt, by diſcovering the ſizes of the particles, may determine many things relating to their mutual actions. The ſolutions of metals in acids, by affording many ſingular and vivid taſtes, and ſometimes colours, ſeem to deſerve eſpecial notice here.

Thirdly, There are many regular changes in natural bodies, which, by compariſon with other phænomena,

nomena, may be of uſe. Thus it is remarkable, that the juice of many or moſt fruits is firſt acid, *i. e.* whilſt unripe, then ſweet, then vinous, after the firſt fermentation, then acid again, after the ſecond fermentation.

This inquiry is of great importance in medicine and philoſophy. And the theory of taſtes appears capable of becoming a principal guide in diſcovering the mutual actions of the ſmall particles of bodies. The difficulty is to make a beginning. This theory may not perhaps be more complex than that of colours; one may, at leaſt, affirm, that the theory of colours appeared as complex and intricate before Sir *Iſaac Newton*'s time, as that of taſtes does now; which is ſome encouragement to make an attempt.

PROP. XXXIX.

To examine how far the ſeveral Senſations, which affect the Stomach and Bowels, may be explained agreeably to the Doctrine of Vibrations.

It will eaſily be conceived, that if taſtes, properly ſo called (of which under the laſt propoſition), favour, or ſuit with, the doctrine of vibrations, the ſenſations of the ſtomach and bowels may likewiſe. But a particular examination of theſe ſenſations, and compariſon of them with taſtes, will make this more evident.

Firſt, then, we may obſerve, that the ſtomach is leſs ſenſible than the tongue, the bowels in general than the ſtomach, and the inferior bowels than the ſuperior. Thus opium, and bitters, and ſometimes ſpirituous liquors are diſagreeable to the tongue, but fall within the limits of pleaſure in the ſtomach. Thus bile is extremely nauſeous in the mouth, and offends even the ſtomach; but it cannot be diſagreeable to the *duodenum*, which it firſt enters, or the bowels, through which it paſſes. Thus alſo the *fæces* ſeem to be equally ſuited to the ſeveral bowels along which they deſcend, though they grow perpetually more putrid and acrimonious in their deſcent; *i. e.* there is an abatement of ſenſibility in the bowels, which correſponds to the increaſe of acrimony in *fæces*.

If it be objected here, that honey, *mercurius dulcis*, &c. offend the ſtomach and bowels often, though pleaſant or inſipid in the mouth, I anſwer, that ſuch bodies require time, heat, ſolution, &c. before the whole of their qualities can be exerted.

Secondly, The particular manner in which opiates, fermented liquors, grateful aliments, and narcotics, may act firſt upon the ſtomach and bowels, and afterwards upon the whole body, agreeably to the doctrine of vibrations, has been given above in treating of ſleep.

Thirdly, The action of vomits, purges, and acrid poiſons, ſuch as corroſive ſublimate, is very reconcileable to this doctrine, by only ſuppoſing, that they excite very vigorous vibrations, and that theſe are communicated to the muſcular coats of the ſtomach and bowels, to the muſcles of the *abdomen*, and, in violent caſes, to the whole muſcular and nervous ſyſtem. I ſhall conſider the automatic motions, which ariſe from theſe cauſes, below, under a particular propoſition. It may ſerve to ſhew the analogy of the ſenſations, and the general nature of active medicines, to obſerve, that theſe will often operate in ſeveral ways, viz. as vomits, purges, diuretics, diaphoretics, ſternutatories, veſicatories, and corroſives, by a change of application and circumſtances.

Fourthly, Since the meats, to which particular perſons have an antipathy, and from which they receive violent ill effects, are, in general, highly grateful to others, one may perhaps conjecture, that the vibrations excited by theſe meats in the ſtomachs of thoſe who have an antipathy to them, do but juſt paſs the limits of pleaſure; ſo as to diffuſe themſelves much farther, and more powerfully, than if the firſt impreſſion was very painful.

Laſtly, The connection between the ſenſations of the tongue and ſtomach, and conſequently between the manners of explaining them, may be inferred from the office of the taſte, as a guide and guard to the organs of digeſtion; which is very evident, in general, in all animals, notwithſtanding a few exceptions, more eſpecially in men.

PROP. XL.

To examine how far the Phænomena of Hunger are agreeable to the Doctrine of Vibrations.

NATURAL hunger may be reckoned a pleaſure in its firſt riſe, and to paſs into a pain only by increaſe and continuance. We may ſuppoſe therefore, that during hunger the nerves of the ſtomach are ſo irritable, as that the common motions of the muſcular coat, and the impreſſions made by its contents, in conſequence of theſe motions, excite ſuch vigorous vibrations, as firſt lie within the limits of pleaſure, and afterwards paſs into the limits of pain. And when the ſight of food, or any other aſſociated circumſtance, increaſes the ſenſe of hunger inſtantaneouſly, it may be conjectured to do ſo, in great meaſure, by increaſing the contractions of the muſcular coat of the ſtomach.

But the ſenſibility and irritability of the nerves of the tongue are alſo increaſed by hunger; for common aliments yield a very different taſte, according as the perſon is ſatiated or hungry. And it is probable farther, that the nerves of the upper part of the bowels ſympathize with thoſe of the ſtomach in hunger; and increaſe the uneaſy ſenſation, in violent degrees of it.

Let us now conſider in what way food may be ſuppoſed to leſſen this ſenſibility and irritability of the nerves of the tongue, ſtomach and bowels; and how abſtinence, bitters, wines, &c. may increaſe them, upon the principles of theſe papers.

Firſt, then, As the ſmall abſorbing veſſels in the mouth, ſtomach, and bowels, muſt, after eating for ſome time, be ſaturated with alimentary particles, thoſe that are now applied will ſcarce make any impreſſion for want of a ſufficient attraction.

Secondly, Such as are attracted cannot make any conſiderable difference of vibrations, becauſe the vibrations which they are qualified to excite, do already take place. And theſe two remarks put together, ſhew, that a perſon may reliſh a ſecond kind of food after being ſatiated with a firſt.

Thirdly, The actions of maſtication, deglutition, and digeſtion, exhauſt the neighbouring glands and glandular receptacles of their liquids, and the neighbouring muſcular fibres, of their ready power of contracting: theſe parts are therefore no longer ſuſceptible of a pleaſurable ſtate, or only in a low degree.

Fourthly, Abſtinence reverſes all theſe ſteps; in which, however, the perpetual affuſion, dilution, and ablution of the ſaliva has a conſiderable ſhare. And thus after a proper interval the organs return to a ſtate of great ſenſibility and irritability.

Fifthly, Bitters and acids exhibited in a moderate degree ſeem gently to increaſe the vibratory motions, and raiſe them before the due time to the degree that correſponds to hunger. A ſmall quantity of food has the ſame effect, alſo agreeable emotions of mind, freſh air, exerciſe, and many other things. But if the bitters, acids, &c. be carried beyond a certain degree, they occaſion pain or ſickneſs, which is very agreeable to the doctrine of vibrations, as laid down in theſe papers.

Sixthly, In fevers the mouth, *fauces*, *oeſophagus*, and ſtomach, are hot, dry, inflamed, and incruſted. They are therefore preoccupied by vibrations of a kind quite different from thoſe which attend hunger, and therefore exclude this ſtate.

It may not be amiſs to obſerve here, that the ſenſation of hunger is a guide and guard to the organs of digeſtion in a ſtill more eminent degree, than the taſtes of the ſeveral aliments.

PROP. XLI.

To examine how far the Phænomena of Thirſt are agreeable to the Doctrine of Vibrations.

THIRST is oppoſite to hunger, and is a general attendant upon fevers. It follows alſo, in an evident manner from all conſiderable degrees of heat in the *fauces*. The nerves therefore of the mouth, *fauces*, *eoſophagus*, and ſtomach, are, during thirſt, preoccupied by diſagreeable vibrations of the inflammatory kind, as above obſerved. And as the pleaſures of taſte may be ſaid to reſemble thoſe of titillation, ſo thirſt ſeems allied to itching.

It is agreeable to this account of thirſt, that liquors actually cold afford immediate relief; alſo that warm diluents, which ſoften the parts, and waſh off acrimonious particles, do it after ſome time. As the cauſe of thirſt is of a permanent nature in fevers, it muſt return again and again, till the fever be removed. Gentle acids yield a pleaſure in thirſt, which ſeems to correſpond to that which ſcratching excites in parts, that itch previouſly.

PROP. XLII.

To examine how far the Changes generally made in the Taſte, in paſſing from Infancy to old Age, are agreeable to the Doctrines of Vibrations and Aſſociation.

Some of theſe changes are,

That ſweets generally grow leſs and leſs agreeable, and ſometimes even diſagreeable, or nauſeous at laſt.

That aſtringent, acid, and ſpirituous liquids, which diſpleaſe at firſt, afterwards become highly grateful.

That even bitters and acrids firſt loſe their offenſive qualities, and after a ſufficient repetition give a reliſh to our aliment.

And that many particular foods and medicines become either extremely pleaſant or diſguſting, from aſſociations with faſhion, joy, hope of advantage, hunger, the pleaſures of cheerful converſation, &c. or with ſickneſs, vomitings, gripings, fear, ſorrow, &c.

Now, in order to account for theſe changes, we may conſider the following things.

Firſt, That the organs become leſs and leſs ſenſible by age, from the growing calloſity and rigidity of all the parts of animal bodies. The pleaſant ſavours may therefore be expected to become leſs pleaſant, and the moderately diſagreeable ones to fall down within the limits of pleaſure, upon this account.

But, how should sweets become nauseous & dis agreeable?

Secondly, The diſpoſition to vibrations in the organ and correſponding part of the brain muſt alſo receive ſome alteration by the frequent repetition of impreſſions. For though this returns, at a proper diſtance from each meal, to its former ſtate, within an indefinite diſtance, as one may ſay, yet ſome difference there probably is, upon the whole, which in a ſufficient length of time amounts to a perceptible one. However, we muſt alſo ſuppoſe on the other hand, that the make of the nervous ſyſtem ſets ſome bounds to this gradual alteration in the diſpoſition to vibrate; elſe the taſte would be much more variable than it is, and continue to change more after adult age, than it is found to do in fact. It may perhaps change faſter in the uſe of a high diet than of a low one; which would be an evidence of the reality of the cauſe here aſſigned.

Thirdly, The pleaſant and painful impreſſions which particular foods and medicines make upon the ſtomach, always either accompany the taſte, or follow it in a ſhort time; and by this means an aſſociation is formed, whereby the direct pleaſantneſs or nauſeouſneſs of the taſte is enhanced, if the impreſſions upon the tongue and ſtomach be of the ſame kind; or diminiſhed, and perhaps overpowered, and even converted into its oppoſite, if they be of different kinds. For if the two impreſſions *A* and *B*, made upon the tongue and ſtomach reſpectively, be repeated together for a ſufficient number of times, *b* will always attend *A* upon the firſt moment of its being made. If therefore *B* be of ſuch a magnitude as to leave a trace *b* ſufficiently great, the addition of this trace *b* to *A*, the impreſſion made upon the tongue, may produce all the changes in it above-mentioned, according to their ſeveral natures and proportions. This follows from the doctrine of aſſociation, as it takes place in general; but here the free propagation of vibrations from the ſtomach to the mouth, along the ſurface of the membranes, adds a particular force. In like manner a diſagreeable taſte, by being often mixed with a pleaſant one, may at laſt become pleaſant alone, and *vice verſa:* hunger and ſatiety may alſo, by being joined with particular taſtes, contribute greatly to augment or abate their reliſh. And I believe it is by the methods of this third kind, that the chief and moſt uſual changes in the taſte are made.

Fourthly, The changes which are made by aſſociations with mental pleaſures and pains, or bodily ones not belonging to this organ, as with fine colours, muſic, &c. receive a like explication as the laſt-mentioned inſtances of aſſociations. Here the pleaſure excited in the eye or ear over-rules the taſte at firſt: afterwards we may ſuppoſe the organ to be ſo altered by degrees, in reſpect of the diſagreeable taſte, from its frequent impreſſion, or other cauſe, as to have the ſolution of continuity no longer occaſioned by its action. It is probable alſo, that evaneſcent pleaſures of ſight and hearing, at leaſt pleaſant vibrations in the parts of the brain correſponding to theſe two organs, accompany theſe taſtes ever afterwards.

It may be obſerved here, that the deſire of particular foods and liquors is much more influenced by the aſſociated circumſtances, than their taſtes, it being very common for theſe circumſtances, particularly the ſight or ſmell of the food or liquor, to prevail againſt men's better judgment, directing them to forbear, and warning them of the miſchiefs likely to ariſe from ſelf-indulgence.

PROP. XLIII.

To examine how far the Longings of pregnant Women are agreeable to the Doctrines of Vibrations and Aſſociation.

Here we muſt lay down previouſly, that the *uterus* is in a ſtate of diſtention during pregnancy; and that it propagates ſympathetic influences by means of nervous communications to the ſtomach, ſo as to put it into a ſtate of great ſenſibility and irritability. All this will be eaſily acknowledged.

It follows therefore, ſince the limits of pleaſure and pain are contiguous, that the ſtomach during pregnancy may at ſome times have an eager appetite for food, as well as a nauſea at others; that this appetite may be the more eager, becauſe it borders upon a nauſea; and that it will no more anſwer to the uſual exigencies and circumſtances of the body, than the nauſea does. The ſame eager appetite will bring up the ideas of various aliments from prior aſſociations; and if a new aſſociation of it, when particularly eager, happens to be made with this or that food or liquor, the ſympathetic eager appetite will ever after bring in the idea of that food or liquor, and adhere inſeparably to it. The ſame eager appetite may alſo be transferred upon ſomething that is not properly a food, from its exorbitant nature, prior nauſeas in reſpect of common food, and accidental joint appearance. And, upon the whole, the uſual circumſtances attending the longings of pregnant women are deducible from aſſociation, and are as agreeable to the doctrine of vibrations, as to any other yet propoſed; or even more ſo.

It may illuſtrate this account to obſerve, that, in the uſual caſes of melancholy madneſs, an uneaſy ſtate ſeems to be introduced into the white medullary ſubſtance of the brain by the degeneration of the humours, or other ſuch like mechanical cauſe, which carries the vibrations within the limits of pain, and raiſes an inflammation *ſui generis* in the infiniteſimal veſſels of the medullary ſubſtance; that ideas of objects of fear, ſorrow, &c. are raiſed, in conſequence of this, by means of prior aſſociations; and that, after ſome time, ſome one of theſe, by happening to be preſented oftener than the reſt, by falling more in with the bodily indiſpoſition, &c. overpowers all the reſt, excites and is excited by the bodily ſtate of fear, ſorrow, &c. till at laſt the perſon becomes quite irrational in reſpect of this one idea, and its immediate and cloſe aſſociates, however rational he may be in other reſpects. And a like account may be given of the violent particular deſire towards a perſon of a different ſex, where this deſire reſts chiefly in the ſenſual gratification, and the beauty of the perſon. And all theſe three inſtances ſeem to me to favour the doctrine of vibrations a little, as well as that of aſſociation very much.

PROP. XLIV.

To explain in what Manner and to what Degree, pleaſant and unpleaſant Taſtes contribute, according to the Doctrine of Aſſociation, to form our intellectual Pleaſures and Pains.

THE pleaſures of the Taſte, conſidered as extending itſelf from the mouth through the whole alimentary duct, are very conſiderable, and frequently repeated; they muſt therefore be one chief means, by which pleaſurable ſtates are introduced into the brain, and nervous ſyſtem. Theſe pleaſurable ſtates muſt, after ſome time, leave miniatures of themſelves, ſufficiently ſtrong to be called up upon ſlight occaſions, viz. from a variety of aſſociations with the common viſible and audible objects, and to illuminate theſe, and their ideas. When groups of theſe miniatures have been long and cloſely connected with particular objects, they coaleſce into one complex idea, appearing, however, to be a ſimple one; and ſo begin to be transferred upon other objects, and even upon taſtes back again, and ſo on without limits. And from this way of reaſoning it may now appear, that a great part of our intellectual pleaſures are ultimately deducible from thoſe of taſte; and that one principal final cauſe of the greatneſs and conſtant recurrency of theſe pleaſures, from our firſt infancy to the extremity of old age, is to introduce and keep up pleaſurable ſtates in the brain, and to connect them with foreign objects.

The ſocial pleaſures ſeem, in a particular manner, to be derived from this ſource; ſince it has been cuſtomary in all ages and nations, and is, in a manner, neceſſary, that we ſhould enjoy the pleaſures of taſte in conjunction with our relatives, friends, and neighbours.

In like manner, nauſeous taſtes, and painful impreſſions upon the alimentary duct, give riſe and ſtrength to mental pains. The moſt common of theſe painful impreſſions is that from exceſs, and the conſequent indigeſtion. This excites and ſupports thoſe uneaſy ſtates, which attend upon melancholy, fear, and ſorrow.

It appears alſo to me, that theſe ſtates are introduced, in a great degree, during ſleep, during the frightful dreams, agitations, and oppreſſions, that exceſs in diet occaſions in the night. Theſe dreams and diſorders are often forgotten; but the uneaſy ſtates of body, which then happen, leave veſtiges of themſelves, which increaſe in number and ſtrength every day from the continuance of the cauſe, till at laſt they are ready to be called up in crowds upon ſlight occaſions, and the unhappy perſon is unexpectedly, and at once, as it were, ſeized with a great degree of the hypochondriac diſtemper, the obvious cauſe appearing no ways proportionable to the effect. And thus it may appear, that there ought to be a great reciprocal influence between the mind and alimentary duct, agreeably to common obſervation; which is farther confirmed by the very large number of nerves diſtributed there.

PROP. XLV.

To give an Account of the Ideas generated by the ſeveral Taſtes.

As the pleaſures of taſte are in general greater than thoſe of feeling, and the pains in general leſs, it follows that the ideas which are affixed to the ſeveral words expreſſing the ſeveral pleaſant and unpleaſant taſtes, will be of a middle nature in reſpect of the ideas generated by tangible impreſſions; and lie between the ideas of the pains of feeling, and thoſe of its pleaſures.

Agreeably to this, it ſeems very difficult, or even impoſſible, to excite a genuine vivid miniature of an acid, ſweet, ſalt, or bitter taſte, by the mere force of imagination. However, the vibrations peculiar to each of theſe leave ſuch veſtiges of themſelves, ſuch an effect in the tongue, and correſponding parts of the brain, as, upon taſting the qualities themſelves, at once to bring up the names whereby they are expreſſed, with many other aſſociated circumſtances, particularly the viſible appearances of the bodies endued with theſe qualities. And theſe veſtiges may be called ideas. Analogy leads us alſo to conclude, as before obſerved under feeling, that ſome faint veſtiges or ideas muſt be raiſed in the parts of the brain correſponding to the tongue, upon the mere paſſage of each word, that expreſſes a remarkable taſte, over the ear. And, when the imagination is aſſiſted by the actual ſight or ſmell of a highly grateful food, we ſeem able to raiſe an idea of a perceptible magnitude. This is confirmed by the manifeſt effect exerted upon the mouth, and its glands, in ſuch caſes.

The ſight of what we eat or drink ſeems alſo, in ſeveral inſtances, to enable us to judge more accurately of the taſte and flavour; which ought to be effected, according to this theory, by raiſing ſmall ideas of the taſte and flavour, and magnifying the real impreſſions in conſequence thereof. For an actual impreſſion muſt excite vibrations conſiderably different, according to the difference in the previous ones; and where the previous ones are of the ſame kind with thoſe impreſſed, the laſt muſt be magnified.

PROP. XLVI.

To explain the automatic Motions, which ariſe from the Impreſſions made on the Organ of Taſte.

THE motions dependent on the ſenſations of the tongue, and alimentary duct, may be thus enumerated: ſuction, maſtication, deglutition, the diſtortion of the mouth and face in conſequence of nauſeous taſtes, the periſtaltic motion of the ſtomach and bowels, vomiting, *ructus*, hiccough, ſpaſms, and violent motions in the bowels, the motions which empty the neighbouring glands, and the expulſion of the *fæces*.

Firſt, then, Suction in new-born children appears to depend chiefly on the ſenſations of the lips and tongue. I ſay *chiefly*, becauſe ſome prediſpoſition thereto may be generated *in utero*, or otherwiſe impreſſed, and the great aptneſs of new-born children in ſucking ſeems to favour this. However, when we conſider, that the impreſſions of the cold air upon the lips and mouth in its paſſage to the lungs, of the nipple upon the lips, and of the milk upon the tongue, ought to excite motions in the neighbouring muſcles of the lips, and lower jaw; that the motions which concur to the action of ſuction, are ſuch as might be expected from theſe cauſes; and even that the motions of the head and neck, by which the child indicates the want of a breaſt, may flow from the great ſenſibility and irritability of theſe parts, when the child is hungry; a preſumption ariſes, that the whole action of ſuction, with all its circumſtances, is excited by the impreſſions mechanically or automatically; and that by the running of vibrations from the ſenſory nerves into the neighbouring motory ones.

Secondly, The firſt rudiments of the action of maſtication are derived from that of ſuction, *i. e.* from the alternate motion of the lower jaw neceſſary to ſqueeze out the milk. After this action has been excited for ſome time by the taſte of the milk, it will return with ſufficient facility from the impreſſions made by ſolid food; and the ſame impreſſions may excite other motions in the muſcles of the tongue and cheeks, viz. thoſe which concur to make the action of maſtication in its imperfect and automatic ſtate.

Thirdly, It may appear in like manner, that the pleaſurable impreſſions of the milk upon the tongue, mouth, and *fauces*, of new-born children, may excite thoſe motions of the muſcles of the tongue, *os hyoides*, ſoft palate, and *fauces*, which make the action of deglutition; and conſequently, that this is deducible from ſenſation automatically.

It confirms this poſition, that, according to the theory of theſe papers, the ſoft palate ought to be drawn down by the impreſſions made on the tongue and mouth, not drawn up; ſince this laſt would be to ſuppoſe the ſenſory vibrations to paſs over muſcles that are near, and run to thoſe at a diſtance, which is abſurd. For *Albinus* has proved, both from anatomy, and the obſervation of the fact, that the ſoft palate is drawn down in ſwallowing; not up, according to the opinion of *Boerhaave*.

It confirms it alſo, that nauſeous liquids are immediately and mechanically rejected by young children; the impreſſions ariſing from them producing ſuch a contraction as ſhuts the paſſage.

It confirms it ſtill farther, that young children do not ſwallow their *ſaliva*. For this makes no impreſſion ſufficient to generate the action of deglutition in an automatic way.

We may conjecture here, that the common vibrations, excited in the membrane of the mouth and *fauces*,

fauces, grow particularly ſtrong at the tip of the *uvula*; and that a greater power of contraction is tranſmitted to the neighbouring muſcles upon this account.

Fourthly, It may be obſerved, that nauſeous taſtes diſtort the mouth and face automatically, not only in young children, but even in adults. And for the ſame reaſon, pleaſant ones ought to have a leſs effect, of the ſame kind; as they ſeem to have. And I conjecture, that the diſtortions of the face, which attend grief, alſo the gentle, ſmiling motions, which attend joy, are, in part, deducible from this ſource.

I conjecture alſo, that the *riſus ſardonius*, and the tendency to laughter, which ſome perſons obſerve in themſelves in going to ſleep, have a relation to the forementioned motions of the face. As the muſcles here conſidered are, in great meaſure, cutaneous, they will on this account, be more ſubject to vibrations excited in the mouth, or which run up to it from the ſtomach.

Fifthly, It may eaſily be conceived, that the impreſſions, which the aliment and *fæces* make upon the ſtomach and bowels, may excite the periſtaltic motion in their muſcular coats. It only remains to ſhew, why this ſhould tend downwards. Now, for this, we may aſſign the following reaſons. Firſt, That the action of ſwallowing determines that of the ſtomach to move the ſame way with itſelf, *i. e.* downwards; and that this determination may, in common caſes, carry its influence as far as the great guts. Secondly, That the contraction of the upper orifice of the ſtomach may ſtop the waves that ſometimes come upwards in the ſtomach, and return them back, ſo as to force open the *pylorus* where that is leſs contracted; as on the other hand, where the *pylorus* is more contracted than the upper orifice, the motion of the ſtomach is inverted, and there ariſes a diſpoſition to *ructus* or vomiting. Thirdly, That, when waves aſcend in the lower bowels, a gentle contraction in the *pylorus* may be ſufficient to ſtop and return them. Fourthly, That one principal uſe of the *cæcum* and *appendicula vermiformis*, which laſt is an extreme and pointed part, ſeems to be, to return the waves, which the conſtriction of the *anus* may ſend upwards. And the effects of glyſters and ſuppoſitories in procuring ſtools, *i. e.* in putting the whole *colon* into motion, agree well with this uſe of the *cæcum*, and *appendicula vermiformis*. It agrees alſo with all the reaſoning of this paragraph, that when a ſtoppage is made any where in the bowels by an inflammation, ſpaſm, ſtrangulation from a rupture, &c. the periſtaltic motion is inverted.

I have been informed, that in a perſon who had ſome inches of the *ilium* hanging out of his body, ſo that the periſtaltic motion might be viewed, the leaſt touch of a foreign body would ſtop this motion at once. It agrees with this, that when rabbits are opened alive, the periſtaltic motion does not take place till after ſome time, viz. becauſe the handling of the bowels has checked it. May we not hence ſuſpect, that the fibres of the muſcular coat of the bowels are contracted by an electrical virtue, which paſſes off, and diſappears for a time, upon the touch of non-electrics? Or may we ſuppoſe, that ſuch touches ſtop ſubtle vibrations in the ſmall parts of the fibres?

Sixthly, Since vomiting is excited by diſagreeable and painful impreſſions in the ſtomach, and requires the contraction of the diaphragm, and abdominal muſcles, it agrees well with the notion, that ſenſory vibrations run into the neighbouring muſcles for contracting them. I ſuppoſe alſo, that both orifices of the ſtomach are ſtrongly contracted, previouſly to vomiting; and that the upper orifice, being moſt ſenſible, is contracted moſt ſtrongly. Hence its power of contraction may be ſoon exhauſted, and conſequently it may open of itſelf in the action of vomiting. However, it may, in ſome caſes, require to be forced open by the ſuperior action of the diaphragm, and abdominal muſcles. Almoſt all great pains and diſorders in the lower belly occaſion vomiting; which is very agreeable to the foregoing notion.

The noſe itches, the mouth flows with water, the lower lip trembles, both are pale, and the perſon yawns, previouſly to vomiting, in many caſes; all which things favour the notion of vibrations running freely along the ſurfaces of membranes.

Ructus, or the expulſion of wind from the ſtomach, is nearly related to vomiting, differing rather in degree than kind. Its ſuitableneſs therefore to the theory of theſe papers muſt be judged of from what has been advanced concerning vomiting.

The hiccough is alſo related to vomiting. It is ſuppoſed to proceed from an irritation at the upper orifice of the ſtomach, cauſing a ſudden contraction of the diaphragm, ſo as to pull down the *pharynx* and *larynx* after it. May it not rather be a ſudden contraction of the inferior or ſmall muſcle of the diaphragm only? This is particularly near the ſuppoſed ſeat of irritation; and upon this ſuppoſition, ſneezing, ſurprize, and all other methods of making the whole diaphragm act together ſtrongly, would remove it, as is obſerved in fact.

Seventhly, Permanent ſpaſms, and violent motions, in the bowels, ariſe in conſequence of uneaſy and painful impreſſions there from indigeſted aliment, acrid *fæces*, irritating purges, poiſons, &c. They are generally attended with the fermentation of the contents of the bowels, and the conſequent generation of air; which, when confined by a ſpaſm on each hand, diſtends the intermediate part of the bowel often to an exceſſive degree, cauſing a proportional degree of painful vibrations. If we ſuppoſe theſe vibrations to check themſelves all at once, by occaſioning a ſudden contraction in the affected membrane, they may be propagated over the whole nervous ſyſtem inſtantaneouſly, and give riſe to the convulſion fits, which happen to young children from gripes, and diſtention of the ſtomach and bowels, and to adults, from poiſons, &c. This is upon ſuppoſition, that neither ſpaſm gives way; for, if either does, the pain goes off, for a time at leaſt, without farther ill ſymptoms. Such pains in the bowels reſemble thoſe in the bladder, when the *detruſor* and *ſphincter* are both contracted violently at the ſame time, by the irritation of a ſtone. The ſtomach, the gall-bladder, and *rectum*, all ſeem capable of like contractions in muſcular fibres, that have oppoſite actions. The cauſes of all theſe ſpaſms and motions are evidently the impreſſions in the neighbourhood, and their circumſtances are, at firſt ſight, agreeable to the theory of theſe papers.

Eighthly, The glands belonging to the mouth, and alimentary duct, appear to me to be emptied, not only by the compreſſion, which the neighbouring muſcles and muſcular fibres make upon them, but alſo by the ſenſory vibrations which run up their excretory ducts, into the *folliculi*, and receptacles where there are ſuch, and even into the ſecretory ducts; by which the periſtaltic motion of all theſe is increaſed, ſo as both to receive more freely from the blood during their ſtate of relaxation, and to ſqueeze more ſtrongly through the excretory ducts during their ſtate of contraction. Thus tobacco, *pyretbrum*, and other acrids, ſolicit a profuſe diſcharge from the ſalival glands, by being barely kept in the mouth, *i. e.* though the neighbouring muſcles do not ſqueeze the glands by the action of maſtication. Thus, likewiſe vomits and purges increaſe both the ſecretions of all the glands of the inteſtines, and thoſe of the liver and *pancreas*. It may be alſo, that the vibrations which run up the gall-duct are ſometimes ſo ſtrong as to occaſion a ſpaſm there; in which caſe, if the patient vomits at the ſame time, a ſymptomatic and temporary jaundice may follow.

Ninthly, The expulſion of the *fæces* in new-born children is perfectly automatic, and ſeems to follow even from very gentle compreſſions of the abdominal muſcles, when the *rectum* is full, inaſmuch as the *ſphincter ani* has in *them* ſcarce any force. The ſame may be ſaid of the expulſion of the urine, the *ſphincter veſicæ* being alſo very weak in new-born children. To which we may add, that the leaſt irritation from fulneſs or acrimony in the *rectum* or bladder throws the abdominal muſcles into contraction in young children, both on account of the extreme ſenſibility and irritability of their whole nervous ſyſtems, and becauſe they have, as yet, no aſſociated influences over the muſcles of the *abdomen*, whereby to reſtrain their contractions.

As the ſphincters of the *rectum* and bladder gain ſtrength, more force is required to expel the *fæces* and urine. However, it appears, that theſe muſcles uſually exhauſt themſelves, previouſly to the inſtant of expulſion, thus giving free ſcope to their antagoniſts. For, according to theory, they ought to be contracted ſooner and ſtronger than their antagoniſts, as being nearer to the ſeat of irritation.

The actions of vomiting, and expulſion of the *fæces*, are very nearly related to one another in their automatic ſtate. However, it ſeems to me, that an irritation in the ſtomach produces only a gentle contraction in the *ſphincter ani*, viz. ſuch a one as does not exhauſt its power, and which therefore tends to confine the *fæces*. In like manner, an irritation in the *rectum* may gently contract the upper orifice of the ſtomach. It deſerves notice here, that the *ſphincter ani* lies out of the *peritonæum*; and conſequently,

quently, that vibrations cannot run from it to the orifice of the ſtomach along the *peritonæum*, nor *vice verſa*. The ſame obſervation holds in reſpect of the *ſphincter* of the bladder.

The circumſtances attending the excluſion of the *fœtus*, which continues automatic perfectly or nearly, may be much illuſtrated by what is here delivered concerning the expulſion of the *fæces*.

PROP. XLVII.

To explain the Manner and Degree in which the automatic Actions, mentioned under the laſt Propoſition, are influenced by voluntary and ſemivoluntary Powers.

When young children continue to ſuck, or maſticate a taſteleſs body put between their lips, or into their mouths, we may conceive, that the actions of ſuction and maſtication begin to paſs from their automatic towards their voluntary ſtate. Drinking out of a veſſel, ſo as to draw up the liquid, is learnt, in part, from ſucking the breaſt, in moſt caſes; but it may be learnt without, as is evident in thoſe children that are dry-nurſed. Maſtication, when it approaches to a perfect ſtate in children, is chiefly voluntary, the firſt rudiments receiving perpetual changes, ſo as to fall in more and more with pleaſure and convenience. See *Prop.* 22. *Cor.* 1. In adults, both ſuction and maſtication follow the command of the will with entire readineſs and facility. The manner in which this is effected has been already explained in treating of the voluntary power of graſping.

Deglutition of inſipid liquors becomes voluntary early. But it is difficult, even for ſome adults, to ſwallow pills and boluſes, though taſteleſs; and very nauſeous liquids are ſometimes rejected by them automatically, as well as by young children. The action of deglutition affords manifeſt evidences of the gradual tranſition of automatic motions into voluntary ones, as well as of voluntary ones into ſuch as are ſecondarily automatic. For, in common caſes, we ſwallow without the leaſt expreſs intention.

When the face of a child or adult is diſtorted upon the ſight of a nauſeous medicine, which has before produced diſtortions automatically, *i. e.* from the impreſſions made on the mouth and *fauces*, we ſee an evident inſtance of the power of aſſociated circumſtances; and may have the conception of voluntary powers, derived from a ſucceſſion of ſuch aſſociations, made eaſy to the imagination.

The periſtaltic motion of the ſtomach and bowels remains automatic to the laſt, depending partly on the vibrations deſcending from the brain, partly on the impreſſions made on the villous coat. It cannot depend on aſſociated circumſtances in its common ſtate, becauſe, being perpetual, it is equally aſſociated with every thing, *i. e.* particularly ſo with nothing. However, as grateful aliments increaſe it, the ſight of them may do the ſame by aſſociation. Could we ſee our ſtomachs and bowels, it is probable, that we ſhould get ſome degree of voluntary power over them.

Vomiting is ſometimes, and a nauſea often, excited by aſſociated circumſtances; and there have been inſtances of perſons who could vomit at pleaſure, by firſt introducing ſome of theſe. But, I ſuppoſe, this action never follows the mere command of the will, without the intervention of ſome ſtrong aſſociated circumſtance. We have, in like manner, a ſemi-voluntary power of reſtraining vomiting, for a time at leaſt, by means of ideas of decency, ſhame, fear, &c.

Some perſons have a power of expelling flatulencies from the ſtomach in a manner which is almoſt voluntary; and many imitate an automatic hiccough very exactly. It facilitates theſe powers, that both the motions here conſidered are very frequent, eſpecially during childhood. Thoſe who can hiccough voluntarily, attain to it by repeated trials, as in other caſes of voluntary actions.

The ſpaſms, and violent motions of the bowels, cannot be expected to become voluntary. They do, however, ſeem to return, in many caſes, from leſs and leſs bodily cauſes perpetually, on account of aſſociated circumſtances, as has been already remarked.

In like manner, the vibrations which run up the excretory ducts of the glands, muſt be ſuppoſed to remain totally under the influence of their original cauſes; unleſs we except the contraction of the gall-duct, which happens ſometimes in violent fits of anger. This may perhaps ariſe from vibrations excited by aſſociated circumſtances.

Both the power of expelling the *fæces* and urine, and that of checking this expulſion, are under the influence of many aſſociated circumſtances, and voluntary to a conſiderable degree. And it will eaſily appear, from the principles of this theory, that they ought to be ſo. The filling the cheſt with air by the contraction of the muſcles of inſpiration, is a circumſtance which never attends theſe actions in their purely automatic ſtate. Young children learn it by the ſame ſteps as they do other methods of exerting the greateſt force, and to the greateſt advantage. See *Prop*. 22. *Cor*. 1.

It deſerves notice here, that the action of the muſcular coat of the ſtomach and inteſtines is far leſs ſubject to the power of the will, than that of the great fleſhy muſcles of the trunk and limbs. The efficient cauſe of this is the great and immediate dependence which the action of the muſcular coat has upon the ſenſations of the villous, on account of the exquiſiteneſs of theſe ſenſations, their conſtant recurrency, and the contiguity of the coats. And there is a perfect agreement of the final cauſe with the efficient here, as in other caſes. For any great degree of voluntary power over the muſcular coat of the bowels would much diſturb the digeſtion of the aliment as thoſe nervous perſons experience, who are ſo unhappy as to be exceptions to the general rule, through the influence of aſſociated circumſtances.

SECT. III.

OF THE SENSE OF SMELL.

PROP. XLVIII.

To aſſign the Extent of the Organ of Smell, and to explain in general the different Powers of which it is poſſeſſed.

SMELL may be diſtinguiſhed into two ſorts: firſt, that exquiſite ſenſation, which odoriferous bodies impreſs upon the noſe by means of alternate inſpiration. This is ſmell, in the peculiar and moſt proper ſenſe of the word; and it reſides chiefly, or perhaps entirely, in that part of the pituitary membrane which inveſts the cells of the *oſſa ſpongioſa*. Secondly, That ſenſation or flavour, which moſt kinds of aliment and medicines impreſs upon the whole pituitary membrane during maſtication, and juſt after deglutition. And this laſt makes a principal part of the pleaſures and pains which are uſually referred to the taſte. For when a perſon has a cold, *i. e.* when the pituitary membrane is obſtructed and loaded with *mucus*, meats loſe their agreeable flavours; and the ſame thing happens in a *polypus narium*.

Beſides this, it is to be obſerved, that the pituitary membrane has an exquiſite ſenſibility, which may be referred to the head of feeling. For active powders, *i. e.* ſternutatories, ſeem to irritate the membrane of the noſe in the ſame way, as they do a part of the ſkin deprived of the cuticle, only in a greater degree, and more immediately. And thus ſmells themſelves may be referred to the head of feeling; ſince ſtrong ſmells are often obſerved to occaſion ſneezing.

It may alſo be remarked, that as the organ of feeling paſſes inſenſibly into that of taſte, ſo the organ of taſte does into that of ſmell. And theſe three ſenſes have a much greater reſemblance to one another, than any of them has to the ſight, or to the hearing; or than the ſight and hearing have to each other. However, the organ of feeling is diſtinguiſhed from that of taſte by its being covered with the hard cuticle, and the organ of taſte from that of ſmell by the laſt's being extended upon bones; ſo as to be much more ſenſible and irritable upon that account. To which we may add, that as a watery fluid is the proper *menſtruum* for the diſſolution of ſapid particles, and conveyance of their taſtes, ſo ſmells ſeem to make their impreſſions by means of air-particles.

PROP. XLIX.

To examine how far the general Phænomena of Smell are agreeable to the Doctrine of Vibrations:

Here we may obſerve, firſt, that, ſince the ſmells of bodies diffuſe themſelves in general to great diſtances, and in ſome caſes to immenſe ones, the odoriferous particles muſt repel each other; and conſequently be eaſily ſuſceptible of vibratory motions, for the ſame reaſons as the particles of common air, or thoſe of the æther. We may even ſuppoſe, that odoriferous particles are thrown off by vibratory motions in the body that emits them.

May not, however, the odoriferous particles be attracted by the body which emits them, after they have receded from it to a certain diſtance, and ſo follow it, in ſome meaſure, like an atmoſphere? It is hard to account for the ſmall or no diminution of weight in odoriferous bodies, after they have continued to emit ſmells for a long time, but upon ſome ſuch ſuppoſition.

Secondly, Heat, friction, and efferveſcence, are all very apt to excite and increaſe ſmells; and have all a connection with vibratory motions in the judgment of moſt philoſophers.

Thirdly, Since heat and friction excite and increaſe ſmells, theſe may have ſome connection with electricity; which is ſuppoſed by many philoſophers to depend upon vibratory motions. And as air-particles are *electrics per ſe*, they may have, on this account, a peculiar fitneſs for conveying and impreſſing ſmells. May not air-particles, and odoriferous ones, repel each other?

Fourthly, It is uſual, when we deſire to receive a ſmell in full ſtrength and perfection, to make quick, ſhort, alternate inſpirations and expirations. This correſponds to the rubbing the ends of the fingers upon the body to be examined by feeling, and the tongue againſt the palate in taſting. And all theſe three actions appear to be ſome preſumption in favour of the doctrine of vibrations.

Fifthly, The greatneſs and quickneſs of the effect of odours upon the whole nervous ſyſtem ſeem very ſuitable to the doctrine of vibrations. For this muſt be owing to the mere impreſſion of ſome motion, there not being time for the abſorption of particles ſufficient for the effect produced. When ſweet ſmells cauſe a ſudden faintneſs, and *deliquium animi*, they may perhaps agitate the whole ſyſtem of ſmall medullary particles ſo much, as to make them attract each other with ſufficient force to ſtop all vibratory motions; juſt as has been obſerved of the particles of muſcular and membranous fibres. And the ſmells to which a perſon has an antipathy, may have been originally ſweet, or lie ſo near the confines of pleaſure, as to propagate their vibrations much farther than original fetids can. For theſe ſeem to revive from fainting by making a vigorous impreſſion on the noſe, which yet is not propagated freely over the whole ſyſtem; or, if it be, will occaſion immediate ſickneſs and fainting. Fetids in this reſemble other pains, which, if moderate, excite; if very violent, overpower.

If it be objected to this, that ſuch fragrant ſmells, as a perſon has an antipathy to, are diſagreeable to him in the higheſt degree, and that upon the firſt perception; alſo that the ſmell of thoſe fetids, which revive, as of *aſa fœtida*, ſpirit of hartſhorn, &c. is agreeable to many; I anſwer, that theſe two oppoſite changes ſeem to ariſe merely from aſſociation. The faintneſs and revival, attending theſe ſmells reſpectively, muſt, by aſſociation, transfer the veſtiges and miniatures of themſelves upon the firſt perception of the ſmells, whoſe aſſociates they are.

Sixthly, It is agreeable to the notion of vibrations, that ſpirituous liquors, and opium, ſhould produce their appropriated effects by ſmell, as well as by being taken into the ſtomach, as they are found to do in fact. For, if theſe effects ariſe from ſpecific vibrations, the mere impreſſion of ſmall active particles may be ſufficient for the purpoſe of producing them. We muſt, however, ſuppoſe that the exhalations of odoriferous bodies are imbibed in ſome ſmall degree by the abſorbing veſſels of the *membrana ſchneideriana.* We might ſhew by parity of reaſon, that the great ſubtlety of odoriferous *effluvia* favours the doctrine of vibrations.

Though odoriferous particles are more ſubtle than the ſapid ones, yet they are perhaps groſſer than the rays of light. For the ſmoke of a tallow candle ceaſes to ſmell, when it begins to ſhine, *i. e.* when it is more attenuated by heat. Since therefore the vibrations from heat are probably ſmaller than thoſe from light, we may range the vibrations of the medullary ſubſtance in the following order, in reſpect of ſubtlety; heat, light, ſmell, taſtes, tangible impreſſions, and the vibrations of the air, from which ſound ariſes. But it is to be obſerved, that theſe laſt may excite much more frequent vibrations in the auditory nerve, than thoſe of the ſounding body, to which they correſpond: juſt as the vibrations from friction are much more numerous, than the ſtrokes of friction; and the tremors of the particles of an anvil much more numerous, than the ſtrokes of the hammer.

PROP. L.

To examine how far the ſpecific Differences of Odours are agreeable to the Doctrine of Vibrations.

THIS propoſition is analogous to the thirty-eighth, in which the agreement of the ſpecific differences of taſtes with the doctrine of vibrations is conſidered; and may be illuſtrated by it. One may ſay indeed, that taſte and ſmell are ſo nearly allied to each other, that, if one be performed by vibrations, the other muſt alſo. I will repeat two principal obſervations.

Firſt, If the varieties of kind in vibrations be combined with thoſe of degree, we ſhall have a large fund for explaining the various fragrant and fetid ſmells, notwithſtanding that the firſt always agree in falling ſhort of the ſolution of continuity, the laſt in going beyond it.

Secondly, The differences of kind in ſmells are not ſo many as may appear at firſt ſight, a difference in degree often putting on the appearance of one in kind. Thus an onion cut freſh, and held cloſe to the noſe, ſmells very like *aſa fœtida*; and *aſa fœtida*, in an evaneſcent degree, like onion or garlic. Thus a dunghil at a diſtance has ſmelt like muſk, and a dead dog like elder-flowers. And fetids are ſaid to enhance the flavour of fragrants. The three laſt inſtances ſhew, that pleaſure and pain are very nearly allied to one another in this ſenſe alſo.

PROP. LI.

To explain in what Manner, and to what Degree, pleaſant and unpleaſant Odours contribute in the Way of Aſſociation, to form our intellectual Pleaſures and Pains.

It will be evident, upon a moderate attention, that the grateful ſmells, with which natural productions abound, have a great ſhare in enlivening many of our ideas, and in the generation of our intellectual pleaſures; which holds particularly in reſpect of thoſe that ariſe from the view of rural objects and ſcenes, and from the repreſentations of them by poetry and painting. This ſource of theſe pleaſures may not indeed be eaſy to be traced up in all the particular caſes; but that it is a ſource, follows neceſſarily from the power of aſſociation.

In like manner, the mental uneaſineſs, which attends ſhame, ideas of indecency, &c. ariſes in a conſiderable degree, from the offenſive ſmells of the excrementitious diſcharges of animal bodies. And it is remarkable in this view, that the *pudenda* are ſituated near the paſſages of the urine and *fæces*, the two moſt offenſive of our excrements.

We may ſuppoſe the intellectual pleaſures and pains, which are deducible from the flavours, grateful and ungrateful, that aſcend behind the *uvula* into the noſe during maſtication, and juſt after deglutition, to have been conſidered in the laſt ſection under the head of taſte, ſince theſe flavours are always eſteemed a part of the taſtes of aliments and medicines. And indeed the olfactory nerves ſeem to have as great a ſhare in conveying to us both the original and derivative pleaſures, which are referred to the taſte, as the nerves of the tongue; which may help us to account for the largeneſs of thoſe nerves in men, to whom ſmell, properly ſo called, is of far leſs conſequence than any other of the ſenſes, and taſte of the greateſt, while yet the nerves of taſte are comparatively ſmall.

We may add here, that the ſmell is a guide and guard placed before the taſte, as that is before the ſtomach, in a great degree in men, but much more ſo in brutes, who have ſcarce any other means, than that of ſmell, whereby to diſtinguiſh what foods are proper for them. It is likewiſe probable, that the ſmell is a guard to the lungs; and that the grateful odours of flowers, fruits, and vegetable productions, in general, are an indication of the wholeſomeneſs of country air; as the offenſiveneſs of putrefaction, ſulphureous fumes, &c. warn us beforehand of their miſchievous effects upon the lungs. However, the rule is not univerſal in either caſe.

PROP. LII.

To give an Account of the Ideas generated by the ſeveral Odours.

WHAT has been delivered concerning the ideas of feeling and taſte, may be applied to the ſmell. We cannot, by the power of our will or fancy, raiſe up any miniatures or ideas of particular ſmells, ſo as to perceive them evidently. However, the aſſociated circumſtances ſeem to have ſome power of affecting the organ of ſmell, and the correſponding part of the brain, in a particular manner; whence we are prepared to receive and diſtinguiſh the ſeveral ſmells more readily, and more accurately, on account of the previous influence of theſe aſſociated circumſtances. And, converſely, the actual ſmells of natural bodies enable us to determine them, though we do not ſee them, always negatively, and often poſitively, *i. e.* by ſuggeſting their names, and viſible appearances. And, when we are at a loſs in the laſt reſpect, the name or viſible appearance of the body will immediately revive the connection.

PROP. LIII.

To explain the automatic Motions, which ariſe from the Impreſſions made on the Organ of Smell.

THESE automatic motions are of three kinds, viz. the inſpiration, by which young brute animals, eſpecially quadrupeds, impreſs and increaſe the odours of their reſpective foods; the contraction of the *fauces*, and upper part of the gullet, which ariſes from thoſe agreeable flavours, which aſcend behind the *uvula* into the noſe; and the action of ſneezing.

As to the firſt; it is peculiar to brutes, children not uſing any methods of improving odours, till they are arrived at two or three years of age. The reaſons of this difference may be, that the ſmell in many brutes is the leading ſenſe; that their noſes are long and large, and the *oſſa ſpongioſa* hollowed by innumerable cells; whereas in young children the noſe is depreſſed; the pituitary membrane loaded with *mucus*; and, when they grow up, the acuteneſs of their ſmell is far inferior to that of quadrupeds.

If it be ſaid, that this action is not automatic in brutes, but an inſtinct, which they bring into the world with them; I anſwer, that the nearneſs of the muſcles affected, viz. thoſe which dilate the noſe, *larynx*, and lungs, to the ſeat of the impreſſion, makes it probable, that the motion depends upon the ſenſation, as in other inſtances mentioned in theſe papers, ſome of which are allowed by all.

It may be, that ſomething of the ſame kind takes place in young children, as ſoon as their ſmell begins to be ſufficiently acute. But it is ſo mixed with, and modelled by, voluntary motions, as to be ſeparately indiſcernible.

The ſecond motion, or the contraction of the *fauces*, and upper part of the *oeſophagus*, from the grateful flavours which aſcend up into the noſtrils behind the *uvula*, is part of the action of deglutition; but it could not properly be mentioned in the laſt ſection, becauſe it ariſes from a ſenſation referred to this.

Ungrateful flavours have often a contrary effect, and extend their influence ſo far as to preclude the paſſage through the gullet, and even throw back the ungrateful liquid or morſel with violence. And we may obſerve, that, in many other caſes alſo, when the pleaſure paſſes into pain, the automatic motion thereon depending paſſes into one of an oppoſite nature; juſt as in algebra, when an affirmative quantity in the *data* is changed into a negative one, a like change is to be made ſometimes, and yet not always, in the concluſion.

It deſerves notice here, that pinching the noſe prevents the perception of theſe flavours, as it ſeems, by checking the vibrations, which would run along the pituitary membrane. When the flavours are very pungent, they fix in the tip of the noſe; or, if this be hindered by pinching the noſe, they fly to the *uvula*, which is the neareſt extreme part to this.

In like manner, pinching the noſe, or preſſing the lacrymal bag, whoſe membrane is continuous to the pituitary one, checks the ſenſation that gives riſe to ſneezing. And when looking at a ſtrong light excites this action, or acrid vapours make the eyes water, we may conjecture, that vibrations paſs through the lacrymal duct from the eye to the noſe in the firſt caſe, and from the noſe to the eye in the laſt. The watering of the eyes from drinking haſtily, eſpecially pungent liquors, from plucking a hair out of the noſtrils, and from ſternutatories, admit of a like explication.

And theſe inſtances may help to explain the ſenſations in the *fauces*, *uvula*, and tip of the noſe, alſo the flowing of tears from the eyes, which attend grief. I conjecture that the ſtomach is particularly affected in grief; and that it ſends up vibrations, along the common membrane, to the *fauces*, *uvula*, tip of the noſe, and eyes. However, the diſorder of the medullary ſubſtance is great and general in great mental uneaſineſſes.

As to ſneezing; no one can doubt its being automatic. And it is reaſonable to expect, that the muſcles actually concerned in it, viz. thoſe of inſpiration, and the erectors of the head and neck, ſhould be affected by vivid ſenſations in the pituitary membrane. It ſeems alſo to me, that the muſcles which ſtop the paſſage through the noſe, ought to be contracted firſt, *i. e.* during the inſpiration, as being nearer to the ſeat of irritation; and afterwards relaxed during expiration, partly by their having exhauſted their own power, partly by the contraction of their antagoniſts, which are irritated alſo. The contrary happens, but for the ſame general reaſons, in the action of deglutition as has been already obſerved. And there is a remarkable coincidence of the efficient and final cauſes in both theſe inſtances.

In ſpeaking of the ſources of motory vibrations above, *Prop.* 18. I ſuppoſed, that, juſt before the motory vibrations excited by the irritation of membranes took place, the ſenſory ones in them were checked by the general contraction of their fibres, in all their directions. And I mentioned ſneezing, as affording an inſtance of this. For the ſenſation, which cauſes it, diſappears the inſtant before the inſpiration; and, if this be not ſtrong enough, *i. e.* if the muſcles do not receive the vibrations from the pituitary membrane with ſufficient freedom, it returns again and again, being increaſed by this reciprocation, till at laſt it cauſes ſneezing. It ſeems agreeable to this account, that the paſſage of air, cold abſolutely or relatively, through the noſe, will often occaſion ſneezing; and through the mouth, yawning. For cold air muſt contract the membranes, along whoſe ſurfaces it paſſes.

When ſneezing rouſes from a ſtupor, it may be ſuppoſed to excite the uſual degree and kind of vibrations in the medullary ſubſtance of the brain, by ſuch a moderate concuſſion of it, as lies within the limits of nature and health.

PROP. LIV.

To explain the Manner and Degree, in which the automatic Actions, mentioned in the laſt Propoſition, are influenced by voluntary and ſemivoluntary Powers.

THE ſhort, quick, alternate inſpirations and expirations, by which we diſtinguiſh ſmells in perfection, are in men, totally or nearly, a voluntary action, derived partly from common reſpiration, partly from ſneezing, the proſpect of pleaſure and convenience concurring to it, and modelling it, as in other caſes. It ſeems alſo, that in brutes this action muſt paſs from its pure automatic ſtate to ſome degree of a voluntary one.

In what manner and degree deglutition is voluntary, has been conſidered already.

Sneezing is checked for a time by attention, ſurprize, and all ſtrong mental emotions. It may alſo be performed voluntarily; but then the force is much inferior to that of automatic ſneezing. The ſame may be obſerved of hiccough, coughing, yawning, ſtretching, &c. and is very agreeable to the derivative nature of theſe motions, when voluntary, *i. e.* when performed by motory vibratiuncles. The action of ſneezing is differently modelled by voluntary and ſemivoluntary powers in different perſons.

SECT.

SECT. IV.

OF THE SENSE OF SIGHT.

PROP. LV.

To determine the immediate Organ of Sight, and explain its Powers in general.

Since the *retina* is an expanſion of the optic nerve, we may conclude, from the analogy of the other ſenſes, that it is the immediate organ of ſight. Nor is the want of ſenſibility in the button of the optic nerve, a ſufficient objection to this; as the minute ſtructure and diſpoſition of the parts of this button are not known.

We may alſo reaſon thus to the ſame purpoſe. It may be expected, that the immediate organ of ſight ſhould be either black or white, that ſo it may bear a relation of indifference to all the colours. But if we admit the doctrine of vibrations, black, by abſorbing all kinds of rays, would make a confuſion of vibrations, whereas white, by reflecting all, might retain the impreſſed vibrations diſtinctly. The *retina* is therefore peculiarly fitted for the immediate organ of ſight, and the *choroides* the contrary. We may add farther, that the *retina*, by reflecting rays copiouſly, prevents their arrival at the *choroides*.

For the accurate diſtinction of the ſeveral viſible points of objects, it is neceſſary, that theſe be placed within the limits of diſtinct viſion; and alſo, that the coats and humours of the eye be ſo circumſtanced, as to bring the ſeveral pencils of rays, which proceed from each viſible point, accurately or nearly, to a correſponding point upon the *retina*. This is diſtinct viſion. But colours alone may be diſtinguiſhed from each other without any exact conformation of the eye. Thus viſion may be reckoned of two kinds, as feeling, taſte, and ſmell, have been.

PROP. LVI.

To examine how far the Phænomena of Colours are agreeable to the Doctrine of Vibrations.

Here I will make two ſuppoſitions.

Firſt, That the extreme red rays at *F M*, *Optics*, book I. part II. fig. 4. excite vibrations in the *retina*, which are to thoſe excited by the extreme violet rays at *A G*, as 1 to 2, in reſpect of frequency.

Secondly, That, in going from the extreme red to the extreme violet, the exceſs of vibrations excited by each colour, above thoſe of the extreme red will be proportional to its diſtance from the extreme red.

If we admit theſe two ſuppoſitions, then the vibrations excited by the extreme red, by the limit of red and orange, of orange and yellow, yellow and green, green and blue, blue and indigo, indigo and violet, and by the extreme violet, as theſe colours are fixed by Sir *Iſaac Newton*, will be to one another in frequency, reſpectively, as the eight numbers 100, $112\frac{1}{2}$, 120, $133\frac{1}{3}$, 150, $166\frac{2}{3}$, $177\frac{7}{9}$, and 200; the diſtances of theſe ſeveral limits, and of the extreme violet, from the extreme red, being to one another reſpectively, as the ſeven numbers $12\frac{1}{2}$, 20, $33\frac{1}{3}$, 50, $66\frac{2}{3}$, $77\frac{7}{9}$, and 100.

Now the firſt ſuppoſition may be rendered probable thus. The intervals of the fits of eaſy reflection and tranſmiſſion of the red and violet in the ſame medium, and ſame angle of refraction, are nearly as 5 to 3. See *Optics*, book II. obſ. 13, 14. and prop. 16. But the red is leſs refracted by the coats and humours of the eye than the violet, and conſequently will not have its intervals ſo much diminiſhed in proportion; whence they may be to thoſe of the violet as 6 to 3, or 2 to 1, at their arrival on the *retina.* But it is probable, that the vibrations of the rays themſelves, and conſequently thoſe which they excite in the *retina*, are reciprocally as the intervals of their fits. The frequency therefore of the vibrations excited by the extreme red may be to that of the vibrations excited by the extreme violet as 1 to 2, according to the firſt ſuppoſition.

The ſecond ſuppoſition is an eaſy ſtep after the firſt. For it is natural to ſuppoſe, that in paſſing from *F* to *A*, in the figure above referred to, equal diſtances ſhould produce an equal increaſe of vibrations, which is the ſecond ſuppoſition.

Upon this foundation we may now reaſon in the following manner.

Firſt, The ſeven primary colours, eſtimated both from their limits, and their middle points, excite vibrations, which are to each other in the ſimpleſt ratios that are conſiſtent with each other, and all comprehended within the firſt and moſt ſimple of all ratios, viz. that expreſſed by the two firſt numbers 1 and 2.

Secondly, The ſame ratios are alſo thoſe of the five tones, and two ſemitones, comprehended within the octave; as might well be expected. For muſic muſt take thoſe which are moſt ſimple, and moſt conſiſtent with each other.

Thirdly, Since the greens are reſpectively to the yellows, on one hand, as 9 to 8, and to the blues, on the other, as 9 to 10, *i. e.* in the proportion of a tone; alſo to the reds, on one hand, as 4 to 3, and to the violets, on the other, as 3 to 4, *i. e.* in the proportion of a fourth; ſince farther, the yellows are as 6 to 5, *i. e.* thirds minor, to the reds, as 4 to

5, *i. e.* thirds major, to the blues, and as 2 to 3, *i. e.* fifths, to the violets; the blues as 5 to 6, *i. e.* thirds minor, to the violets, and as 3 to 2, *i. e.* fifths, to the reds; and the reds as 9 to 16, *i. e.* flat ſevenths, to the violets; the difference of vibrations here exhibited may make the five foregoing colours appear diſtinct from each other to the mind, for the ſame reaſons, whatever they be, as take place in ſounds. For natural bodies reflect all theſe colours in great abundance, and in ſufficient purity for this purpoſe. We may begin from green, as the moſt common of all. When this, as reflected by graſs, ſuppoſe, has been ſufficiently familiarized to the eye of a child, it is reaſonable to think, that it may be diſtinguiſhed from yellow and blue, and much more from red and violet, as reflected by flowers; alſo that theſe may be diſtinguiſhed from each other. And it ſeems to me, that our fixed point ought to be placed in green, from the commonneſs and purity of the green of the third order, *i. e.* of graſs and vegetables in general. For the ſame reaſons one may expect, that the ſeveral ſhades of red, orange, green, blue, and violet, ſhould be conſidered as ſeveral degrees of the ſame colour, viz. on account of the ſmall difference of vibrations. At leaſt this correſponds to the uſual method of proceeding in other things. We diſtinguiſh great differences in our ſenſations by new names; but refer all ſuch as are nearly related to the ſame. And thus the two foregoing ſuppoſitions furniſh us with a natural reaſon for diſtinguiſhing the primary colours into five, viz. red, yellow, green, blue, and violet; which, agreeably to this, were all that Sir *Iſaac Newton* himſelf diſtinguiſhed the oblong ſolar image into for ſome time, as may appear by his Optical Lectures.

Fourthly, Since, if we proceed from the green to the yellow and red, on one hand, and to the blue and violet, on the other, the ratios are the ſame, only inverted;

verted; and ſince there is a larger interval or ratio between the yellow and red, alſo between the blue and violet, than between the green and yellow, or green and blue; we may expect to have two more diſtinct primary colours correſponding to each other, and to the two ſemitones in an octave. And thus it is. Orange, and indigo, are ſufficiently diſtinct from their contiguous ones, viz. orange from red and yellow, and indigo from blue and violet; and yet approach to them. And theſe ſeven colours thus fixed, ſeem to be all that we can well call diſtinct colours amongſt the primary ones, the intermediate degrees being referred to ſome of theſe ſeven, and called ſhades. Of compound colours, diſtinct from all the primary ones, I ſhall ſpeak below.

Fifthly, It is remarkable here, that the order of the five tones and two ſemitones of an octave, which correſponds to the order of the ſeven primary colours, is the ſecond in abſolute perfection (which I have from a M S. paper of Sir *Iſaac Newton*'s on muſic, not yet publiſhed), and the firſt in relative, *i. e.* of thoſe, in which the ſemitones are at equal diſtances from the middle or extremes; which circumſtance is evidently neceſſary in the order of the colours. For if diſtinct colours ariſe from ratios, and a half-note colour ariſe next after the red, if you begin at one end, a correſponding one ought to appear next after the violet, if you begin at the other. The ſameneſs of the ratios, that muſt ariſe, makes this neceſſary, on ſuppoſition, that the diſtinction of colours is founded on ratios.

Sixthly, If the diſtinction of colours ariſe from the ratios of vibrations, the colours may be expected to be broader where the vibrations are more numerous, becauſe a greater addition muſt be made to a greater number, in order to make an equal ratio. And there is a certain breadth for each of the colours reſpectively, which ſuits each ſet of ratios of vibrations that they can be ſuppoſed to bear to one another, according to any ſuppoſed law of increaſe of the vibrations in paſſing from one end of the ſolar image to the other. Since therefore the breadth of the ſeven primary colours, as determined by Sir *Iſaac Newton*, ſuits the ſimpleſt ratios poſſible, according to the ſimpleſt law of increaſe poſſible, as has been explained above, we ſeem to have from thence an argument both for the doctrine of vibrations in general, and for the particular ratios of vibrations here alleged. And there are two things in this matter which deſerve particular notice. Firſt, that Sir *Iſaac Newton*'s *ſpectrum* was about ten inches long; and conſequently, the breadths of the ſeven primary colours, red, orange, yellow, green, blue, indigo, violet, in inches, 1, 25; 0, 75; 1, 33; 1, 66; 1, 66; 1, 11; 2, 22; which magnitudes are ſo conſiderable, that a ſmall error in fixing the limit of a colour does not much affect their mutual ratios. Secondly, That the limits of the colours were determined in a way, that had no dependence on any hypotheſis, and the operation repeated ſeveral times. However, it may perhaps be worth the time and pains of ſome curious experimenter, to examine the breadths of the ſeven primary colours afreſh, and compare them with the hypotheſis here propoſed.

Seventhly, When all the rays reflected from any natural body are near to each other, as in the yellows of the ſecond order, and in the blues and greens of the third, we may ſuppoſe, that the ſlower vibrations are accelerated by the quicker, and the quicker retarded by the ſlower, ſo as to compoſe an intermediate colour, ſcarce differing from homogeneal light in appearance of purity; juſt as in a bell, the ſlower vibrations of the wider part, and the quicker of the narrower, over-rule each other mutually, ſo as to compoſe one tone. But when the vibrations of the extreme rays are greatly different from each other, it ſeems that each ought to keep the power of exciting its proper vibrations, ſo as to make the colour of the middle rays; which may be conſidered as a kind of centre of gravity, a dilute one, verging to white. And white itſelf, when in perfection, ariſes from a due proportion of all the ſorts of rays, each primary colour, perhaps, keeping its own peculiar vibrations, and the ſeveral ſhades of each primary colour vibrating in the ſame time as the middle point. When two colours conſiderably different, as red and blue, yellow and violet, red and violet, are compounded, they neither reſemble the intermediate homogeneal one, nor make a white. Not the firſt, becauſe they are at ſo great a diſtance, that each can keep its own vibrations, contrary to what happens in colours reſembling homogeneal ones; not a white, becauſe there is not a ſufficient number of differing vibrations. By ſuch compoſitions it is, that purples, and other colours, different from all the homogeneal ones, are formed; and whoever conſiders the ſeveral ſhades of each colour, with the mutual proportions which may be combined in any compound, may eaſily conceive how all the colours of natural bodies ſhould ariſe from mere combinations of the primary colours, agreeably to the ſixth and ſeventh propoſitions of the ſecond part of the firſt book of Sir *Iſaac Newton*'s Optics. What is here delivered may ſerve to ſuit the doctrine of vibrations to thoſe propoſitions, and, perhaps, aſſiſt the reader to ſee the reaſons of the ſixth.

Cor. If the differences of the primary colours ariſe from the ſpecific differences of vibrations, it is eaſy to ſee, that the differences of taſtes and ſmells may have a like origin; and *vice verſa*.

PROP. LVII.

To examine how far luminous Appearances, not occaſioned by the Impreſſion of the Rays of Light, with ſome other Phænomena of a related Kind, are agreeable to the Doctrine of Vibrations.

FLASHES of light, and other luminous appearances, are occaſioned by ſtrokes upon the eye, rubbing it, faintings, &c. Now it is very eaſy to conceive, that violent agitations in the ſmall particles of the optic nerve ſhould ariſe from theſe cauſes; and conſequently that ſuch deceptions of the ſight, as one may call them, ſhould be produced, if we admit the doctrine of vibrations. And I do not ſee how they follow from the common hypotheſis concerning the manner of ſenſation.

The moſt remarkable of theſe luminous appearances is that which reſembles the eye of a peacock's feather, and which offers itſelf upon ſhutting and rubbing the eye in a morning. There is a diſtinction in it between the central parts and the edges. The firſt ſeem to anſwer to that part of the *retina*, which is oppoſite to the pupil, and of about the ſame ſize with it, in its ordinary dimenſions. The laſt, or the edges, may anſwer to thoſe parts of the *retina*, which are only ſometimes expoſed to the action of light, viz. in dilatations of the pupil. It is obſervable, that the central parts are often dark, while the edges are luminous; and *vice verſa*. It happens alſo frequently, that in the whole appearance a blue, a dilute yellow, and a red, ſucceed each other in the order of the colours. Perhaps, by farther obſervations, a perſon might be able, in ſome meaſure, to predict the variations of this phænomenon. It generally moves, which may be perhaps from the motion of the peculiar vibrations along the ſurface of the *retina*.

Upon ſhutting one's eyes after they have been fixed upon a luminous object, as a candle, a fire, a window, it is common to have a faint image of the object remain in the eye for a few moments. This follows from the gradual declenſion of the vibrations excited.

Sometimes, inſtead of a luminous image, a dark one, correſponding in ſhape and ſize to the luminous object, preſents itſelf. In this caſe we muſt ſuppoſe, that the vivid vibrations excited by the luminous object paſs immediately into very feeble ones, abſolutely or relatively, upon the ceſſation of the impreſſion.

Boerhaave ſays, that he had a luminous circle in his eye for a long time after having viewed too intenſely the moon's light collected to a *focus*. And looking at the ſun makes other objects appear red and luminous. It does alſo occaſion dark ſpots to appear upon common objects afterwards. This laſt effect may perhaps ſucceed the firſt. While extraordinary vibrations, or a diſpoſition to them, continue in the *retina*, and optic nerve (which may be for a long time, if a ſlight inflammation, with the conſequent irritability, be produced in the ſmall veſſels of the nervous capillaments), the common objects may appear luminous. When theſe go off, a contrary ſtate may take place, and cauſe the dark ſpots to appear. Dark ſpots of continuance argue, that an injury is done to the *retina*, and optic nerve. The permanent dark ſpots, which are ſometimes previous to a *gutta ſerena*, ſeem to be of this kind.

It is agreeable to ſome of the foregoing inſtances, that being kept much in the dark ſhould enable the perſons to ſee with a very obſcure light. In ſome other caſes of a *nyctalopia* there may perhaps be the firſt and loweſt degree of inflammation in the infiniteſimal veſſels of the *retina*, ſo as to increaſe the ſenſibility of the organ without making the exerciſe of its functions painful.

Giddineſs, or an apparent irregular motion in the objects of ſight, almoſt always goes before any general confuſion and privation of ſenſe and motion; which is very agreeable to the doctrine of vibrations. For the general diſorder in the vibrations in the medullary ſubſtance may be expected to be perceived in the optic nerve, and correſponding part of the brain, firſt and chiefly, on account of the acuteneſs and preciſion of the ſenſe of ſight. Upon the ſame principles it is eaſy to ſee, how great and unuſual agitations of the body, impreſſions on the ſtomach, on the olfactory nerves, on the eye, by the quick tranſition of objects, on the eye and fancy together, by looking down a precipice, &c. ſhould occaſion a temporary giddineſs.

PROP. LVIII.

To examine how far the Judgments which we make by Sight concerning Magnitude, Diſtance, Motion, Figure, and Poſition, are agreeable to the Doctrine of Aſſociation.

I HAVE already obſerved, *Prop.* 30. that theſe judgments are to be eſteemed true or falſe, according as they agree or diſagree with thoſe made by touch.

Now the aſſociates of greater tangible magnitude are a larger picture on the *retina*, the diſtance being the ſame; and a larger diſtance, the picture being the ſame. The aſſociates of a leſs tangible magnitude are the oppoſites to theſe. And the aſſociates of the ſameneſs of tangible magnitude are the increaſe or diminution of the picture on the *retina*, while the diſtance is diminiſhed or increaſed ſuitably thereto. All this appears from optical conſiderations. Hence it follows, that where the picture on the *retina* is of a juſt ſize, and alſo the previous judgment concerning the diſtance juſt, our eſtimate of tangible magnitude by ſight will be juſt likewiſe. But if the picture on the *retina* be magnified or diminiſhed by glaſſes, or our previous judgment concerning the diſtance be erroneous, our eſtimate of tangible magnitude will be erroneous in like manner. And, whether it be juſt or erroneous, it is entirely founded on aſſociation.

The following inſtances, among many others, confirm theſe poſitions. Young children judge rightly of magnitude only in familiar places, or at ſmall diſtances. At great diſtances they always judge the objects to be leſs than the truth, not having learnt to judge rightly of theſe diſtances, and make allowance for them. The generality of adults judge far better of magnitude at great diſtances on level ground, than from above, or from below, on account of their greater experience in the former caſe. The horizontal moon appears larger than the meridional, becauſe the picture on the *retina* is of nearly the ſame ſize, and the diſtance eſteemed to be greater. And yet the horizontal moon appears far leſs than the truth, becauſe we can form no conception of its vaſt diſtance. A tree referred to the horizon in the duſk of the evening, or a fly to the ground at a diſtance, through the indiſtinctneſs of viſion, appears much bigger than the truth. In looking through glaſſes, which magnify or diminiſh the picture on the *retina*, the objects themſelves ſeem to be magnified or diminiſhed, becauſe our judgment concerning the diſtance is not altered proportionally, &c. &c.

There are, beſides theſe, ſome other aſſociated circumſtances, which occaſionally impoſe upon us in eſtimating magnitudes. Thus a perſon of an ordinary height ſtanding near a very tall one, or coming in at a very high door, appears ſhorter than the truth; lean perſons ſeem tall, fat perſons ſhort, &c.

The principal criterion of diſtance is the magnitude of the picture, which ſome known object makes on the *retina*. But the five following aſſociated circumſtances ſeem to have alſo ſome influence on our judgments concerning diſtance, in certain caſes, and under certain limitations: the number of objects which intervene, the degree of diſtinctneſs in which the minute parts are ſeen, the degree of brightneſs, the inclination of the optic axes, and the conformation of the eye. It will appear from the ſixty-ſecond and ſixty-third propoſitions that the two laſt are aſſociates to each other in their proper degrees, ſince each depends on the diſtance of the object. The influence of the three firſt, as well as that of the magnitude of the picture on the *retina*, is evident from the methods of expreſſing diſtance in pictures.

From the principles laid down in the laſt paragraph, we may explain the following fallacies in viſion. An object viewed through a perſpective appears to be nearer than it is, becauſe the picture on the *retina* is thereby rendered both larger, and more diſtinct; but if we invert the perſpective, and ſo diminiſh the picture, the object will appear farther off. At ſea, and on plains, where few or no objects intervene, we judge the diſtances to be leſs than the truth; and the contrary happens in ſcenes diverſified with a proper variety of objects. A large object, when apprehended to be one of a common ſize, appears nearer than the truth; and the ſame happens, when we view objects in rural ſcenes, ſuch as houſes, towns, hills, &c. in a bright light, or through a very clear atmoſphere. In trying to judge of ſmall diſtances by one eye, it is uſual to be miſtaken for want of the criterion from the inclination of the optic axes.

Since our judgment concerning the magnitude of an unknown object depends upon the diſtance, and our judgment concerning the diſtance of every object chiefly upon that concerning its magnitude, the conjectures of different perſons, concerning the magnitudes and diſtances of unknown remote objects, both as ſeen through teleſcopes, and with the naked eye, may vary conſiderably from each other according to their reſpective aſſociated prejudices. If the diſtance be fixed previouſly by a known object, we may afterwards judge of the magnitude of an unknown object thereby. The number of intervening objects, and the inclination of the optic axes, ſeem to afford conſiderable aſſiſtance in determining diſtances, where known objects are wanting; the firſt in large diſtances, the laſt in ſmall ones: but the other three inferior criterions above-mentioned, viz. the degree of diſtinctneſs, the degree of brightneſs, and the conformation of the eye, when ſingly taken, are of ſmall ſignification.

We judge of motion by the motion of the pictures on the *retina*, or of our eyes in following the objects. After ſome time, we learn to make allowance for the line of direction, our own motions, &c. If we fail to make the due allowance through aſſociated circumſtances of any kind, we muſt, in conſequence of this, make a diſproportionate eſtimate of motion, or place it in an undue object.

We judge of the figure or ſhape of bodies, chiefly by the variations of light and ſhade; and our aſſociations taken thence are ſo ſtrong, as that we are eaſily impoſed upon by a juſt imitation of the light and ſhades belonging to each ſhape and figure, in their ſeveral ſituations with reſpect to the quarter from which the illumination proceeds.

It is from the aſſociations, conſidered under this propoſition, and particularly in the laſt paragraph, that painting conveys ſuch exact ideas of ſhapes, figures, magnitudes, and diſtances, and the *camera obſcura* of motions alſo, by means of impreſſions that proceed from a plane ſurface.

The poſition of objects is judged of entirely by the part of the *retina* on which the rays fall, if we be in an erect poſture ourſelves. If we be not, we allow for our deviation from it, or make a reference to ſomething judged to be in an erect poſture. If we fail in theſe, errors concerning the poſition of viſible objects muſt happen. Our calling bodies *erect*, when the rays proceeding from their tops fall upon the lower parts of the *retina*, and *vice verſa*, is merely from an aſſociation of the ſame kind with thoſe by which the ſenſes of other words are determined.

Thoſe who are diſpoſed to examine the ſubjects of this and the following propoſition with accuracy, may ſee a large variety of proper inſtances well explained by Dr. *Smith*, and Dr. *Jurin*, in Dr. *Smith*'s Optics. Theſe gentlemen inſiſt chiefly on optical conſiderations; but they every where admit the prevalence of aſſociation, though it is not always to their purpoſe to take expreſs notice of it.

I will juſt remind the reader, that in all the caſes of magnitude, diſtance, motion, figure, and poſition, the viſible idea is ſo much more vivid and ready than the tangible one, as to prevail over it, notwithſtanding that our information from feeling is more preciſe than that from ſight, and the teſt of its truth. However, if we could ſuppoſe a perſon to be endued with the ſenſes of ſeeing and hearing, and yet to be deſtitute of that of feeling, and of the power of moving himſelf, he might have all the words expreſſing diſtances, magnitudes, &c. ſo much, and ſo properly, aſſociated with the viſible appearances of theſe, as that, by paſſing over his ear, they would raiſe up all the ſame trains of viſible ideas, as in us.

PROP. LIX.

To examine how far the Circumſtances of ſingle and double Viſion are agreeable to the Doctrine of Aſſociation.

When we have attained a voluntary power over the external motions of our eyes, ſo as to direct them to objects at pleaſure, we always do it in ſuch a manner, as that the ſame points of objects fall upon correſpondent points of the two *retinas.* And this correſpondence between the reſpective points of the *retinas* is permanent and invariable. Thus the central points, or thoſe where the optic axes terminate, always correſpond; a certain point on the right ſide of the right *retina* always correſponds (whatever object we view) to another certain point on the right ſide of the left *retina,* equally diſtant from the centre with it, &c. Hence, if the optic axes be directed to the object *A,* the picture made by it on the right *retina* correſponds to that made on the left; whereas the impreſſions made by two ſimilar objects, *A* and *B,* upon the two *retinas,* do not correſpond. The impreſſions therefore, that are made upon portions of the *retinas,* which do or do not correſpond, are the aſſociated criterions of ſingle and double viſion. For I here ſuppoſe, that the common appearances of a ſingle object, and two ſimilar ones, are reſpectively called ſingle and double viſion.

Let us now inquire into the fallacies which theſe aſſociated criterions may occaſion.

First, then, When a perſon directs his eyes by a voluntary power to a point nearer or farther off than the object which he views, ſo as to make the pictures of the object fall upon the points of the two *retinas,* that do not correſpond, this object will appear double. The ſame thing happens when one eye is diſtorted by a ſpaſm, when perſons loſe the voluntary power of directing their optic axes to objects, and in general whenever the pictures, which the object imprints on the two *retinas,* fall upon points that do not correſpond.

It reſembles this, and illuſtrates it, that if we croſs the fingers, and roll a pea between two ſides, which are not contiguous naturally, it feels like two peas.

Secondly, After a perſon, whoſe eye is diſtorted by a ſpaſm, has ſeen double for a certain time, this ceaſes, and he gains the power of ſeeing ſingle again, provided the diſtortion remains fixed to a certain degree. For the aſſociation between the points of the two *retinas*, which correſponded formerly, grows weaker by degrees; a new one alſo between points, that now correſpond, takes place, and grows ſtronger perpetually.

Thirdly, If two lighted candles, of equal height, be viewed at the diſtance of two or three feet from the eyes, ſo that the picture of the right-hand candle on the left *retina* ſhall correſpond to that of the left-hand candle on the right *retina*, only one image will be produced by theſe two correſponding pictures. But the two pictures which do not correſpond, viz. that of the right-hand candle on the right *retina*, and that of the left-hand candle on the left *retina*, will each produce its proper image. See *Smith's Optics*, Rem. 526.

But here two queſtions may be aſked: Firſt, Why ſingle objects appear the ſame to one as to both eyes, allowing for the diminution of brightneſs, ſince, in the firſt caſe, there is one picture only, in the laſt two. Ought not every ſingle object to appear ſingle to one eye, and double to both?

Secondly, How can one object appear like two to both eyes, ſince, however the eyes be directed or diſtorted, it can make but two pictures, whereas two objects make four, viz. two in each eye?

It is evident, that the difficulty is the ſame in both theſe queſtions. And it ſeems to be a ſufficient anſwer to allege, that impreſſions ſo much alike, and which are ſo conſtantly made together, as thoſe upon the correſponding portions of the two *retinas*, muſt unite into one entirely in the brain, and produce the ſame effect in kind, though ſomewhat different in degree, as one alone. And thus, whether we ſee with one eye or both, hear with one ear or both, the impreſſion on the common ſenſory in the brain is the ſame in kind; and therefore, if the firſt be called ſingle, the other muſt alſo.

But it deſerves particular attention here, that the optic nerves of men, and ſuch other animals as look the ſame way with both eyes, unite in the (*ſella turcica*) in a *ganglion*, or little brain, as one may call it, peculiar to themſelves; and that the aſſociations between simultaneous ſynchronous impreſſions on the two *retinas* muſt be made ſooner, and cemented ſtronger, on this account; alſo, that they ought to have a much greater power over one another's images, than in any other part of the body. And thus an impreſſion made on the right eye alone by a ſingle object, may propagate itſelf into the left, and there raiſe up an image almoſt equal in vividneſs to itſelf: and conſequently, when we ſee with one eye only, we may, however, have pictures in both eyes; and when we ſee a ſingle object, with our eyes directed to one at a different diſtance, we may have four pictures, viz. two from direct impreſſion in parts that do not correſpond, and two others from aſſociation in parts that do. And thus both the foregoing queſtions may be anſwered, in a manner that leaves no doubt or heſitation.

PROP. LX.

To explain in what Manner, and to what Degree, agreeable and diſagreeable Impreſſions on the Eye contribute, in the Way of Aſſociation, to form our intellectual Pleaſures and Pains.

It is evident, that gay colours, of all kinds, are a principal ſource of pleaſure to young children; and they ſeem to ſtrike them more particularly, when mixed together in various ways. Whether there be any thing in colours, which correſponds to the harmony between ſounds, may be doubted. If there be, it muſt, however, admit of much greater latitude than the harmony between ſounds, ſince all mixtures and degrees of colours, unleſs where the quantity of light overpowers the eye, are pleaſant; however, one colour may be more ſo originally than another. Black appears to be originally diſagreeable to the eyes of children; it becomes diſagreeable alſo very early from aſſociated influences. In adults, the pleaſures of mere colours are very languid in compariſon of their preſent aggregates of pleaſure, formed by aſſociation. And thus the eye approaches more and more, as we advance in ſpirituality and perfection, to an inlet for mental pleaſure, and an organ ſuited to the exigencies of a being, whoſe happineſs conſiſts in the improvement of his underſtanding and affections. However, the original pleaſures of mere colours remain, in a ſmall degree, to the laſt, and thoſe transferred upon them by aſſociation with other pleaſures (for the influence is in theſe things reciprocal, without limits) in a conſiderable one. So that our intellectual pleaſures are not only at firſt generated, but afterwards ſupported and recruited, in part from the pleaſures affecting the eye; which holds particularly in reſpect of the pleaſures afforded by the beauties of nature, and by the imitations of them, which the arts of poetry and painting furniſh us with. And for the ſame reaſons the diſagreeable impreſſions on the eye, have ſome ſmall ſhare in generating and feeding intellectual pains.

It deſerves notice here, that green, which is the colour that abounds far more than any other, is the middle one among the primary colours, and the moſt univerſally and permanently agreeable to the eye of any other: alſo, that as the common juice of vegetables is in general green, ſo that of animals is in general red; the firſt being, perhaps, of the third order, the laſt of the ſecond. It appears to be extremely worth the time and pains of philoſophers to inquire into the orders of the colours of natural bodies, in the manner propoſed and begun by Sir *Iſaac Newton*; and particularly to compare the changes of colour, which turn up in chemical operations, with the other changes which happen to the ſubjects of the operations at the ſame time. Nothing ſeems more likely than this to be a key to the philoſophy of the ſmall parts of natural bodies, and of their mutual influences.

PROP. LXI.

To give an Account of the Ideas generated by viſible Impreſſions.

Here we may make the following obſervations:

Firſt, That the ideas of this ſenſe are far more vivid and definite than thoſe of any other; agreeably to which, the word *idea* denoted theſe alone in its original and moſt peculiar ſenſe. Hence it is proper to make the ſtricteſt examination into the ideas of this ſenſe, and their properties, ſince it is probable, from the analogies every where conſpicuous in natural things, that theſe are patterns of all the reſt. Their peculiar vividneſs and preciſion may therefore be conſidered as ſerving like a microſcope in reſpect of other ideas, *i. e.* as magnifying their properties.

Secondly, The vividneſs and preciſion here ſpoken of relate chiefly to diſtance, magnitude, motion, figure, and poſition, *i. e.* to the things conſidered in the fifty-eighth propoſition. However, colours leave diſtinct ideas of themſelves; but then they require an exertion of our voluntary powers for the moſt part, whereas the ideas of diſtances, magnitudes, &c. recur inceſſantly in the trains which paſs over the fancy.

Thirdly, The peculiar vividneſs and preciſion of viſible ideas may probably be owing to the following cauſes, as well as to ſome peculiar unknown ſtructure of the optic nerve, and correſponding region of the brain; viz. the perpetual recurrency of viſible objects, either the ſame, or ſimilar ones, during the whole time that we are awake; the diſtinct manner in which they are impreſſed by means of the ſeveral proper conformations of the eye; and their being received in general upon the ſame part of the *retina*, preciſely or nearly. For, when we view any object with attention, we make the central point of it fall upon the central part of the *retina*. Farther, as the optic nerve ſends off no branches, but is ſpent wholly upon the *retina*, this may perhaps contribute in ſome degree. And theſe conſiderations may a little help us to conceive how the optic nerve, and correſponding region of the brain, may be the repoſitory of ſuch an immenſe variety of viſible ideas, as they are in fact.

Fourthly, The idea of every familiar object has, for the moſt part, ſome particular magnitude, poſition, and aggregate of aſſociates, in its recurrencies to the mind. And this ſomewhat leſſens the difficulty mentioned in the laſt paragraph. The reaſon of this fourth obſervation is, that though every viſible object appears under different magnitudes, in different poſitions, and with different aſſociates, yet theſe differences deſtroy one another, ſo that the ſtrongeſt particularity only remains. However, changes are made from time to time, each ſubſiſting for a ſhort period, and then giving way to the next in ſucceſſion.

Fifthly, We have fictitious viſible ideas of places and perſons that we have never ſeen, as well as of thoſe which we have. Theſe are derived from aſſociation evidently, and they often undergo ſucceſſive changes, like thoſe ſpoken of in the laſt paragraph.

Sixthly, Our viſible ideas are ſubject to the voluntary power in a high degree, and may be called up by the ſlighteſt aſſociated circumſtance, at the ſame time that they have very numerous connections with other ideas, and with actual impreſſions. The name, or its idea in the region of the brain correſponding to the ear, are the circumſtances moſt commonly made uſe of for calling up viſible ideas. But there are many ideas, *i. e.* internal feelings, which have no names, and which yet, by attending our ſeveral viſible ideas, get this power of introducing them.

Here it is to be obſerved, that an idea cannot be ſaid to be voluntarily introduced, till it be previouſly determined by ſome of its aſſociates. If I deſire to introduce a viſible idea of any kind, an *individuum vagum*, and that of an horſe offers itſelf, it was not owing to the command of my will, that it was an horſe, and nothing elſe, but to the connection which the idea of an horſe had with ſome other idea or impreſſion, which then happened to take place. But if I deſire to recollect the features of a perſon's face, whom I ſaw yeſterday, I make uſe of his name, his dreſs, the place in which I ſaw him, or ſome other aſſociated circumſtance, for this purpoſe. And this may be called a voluntary introduction of an idea. However, the introduction of the idea of an horſe, in the circumſtances juſt deſcribed, might be termed voluntary in a different ſenſe, if any perſon thought fit to denominate it ſo, on account of the command of the will to introduce ſome idea. My deſign here is, only to ſuggeſt to the reader the proceſſes generally made uſe of in theſe things. It is to be obſerved farther, that the aſſociated circumſtance, which determines what idea ſhall be called up voluntarily, does, for the moſt part, raiſe it. Thus, if a perſon deſires me to call up the idea of an horſe, the very ſound of the word proceeding from his mouth will do it, for moſt part, immediately. If not, I go back, by my memory, to the trace left by the word, and thence to the idea, or to ſome common aſſociate of both the word and idea, capable of raiſing the laſt.

Seventhly, When we have converſed much with the ſame viſible objects, as after having been in a crowd, travelling, &c. for many hours without intermiſſion, we may find the ideas of theſe objects peculiarly ſtrong, ſo as to intrude upon our fancies, and interfere with all our other ideas. This may ſerve to ſhew, that the permanence of the ſenſations impreſſed, mentioned in the third propoſition, and which ſhews itſelf particularly in viſible impreſſions, as there remarked, is of the nature of an idea. And it coincides remarkably with this, that the ideas ſhould be peculiarly vivid and preciſe in the ſame ſenſe, where the permanency of the ſenſation impreſſed is moſt conſpicuous.

Eighthly, The ideas of ſight and hearing, and the impreſſions from whence they proceed, have a peculiar connection with each other. For as words pronounced call up viſible ideas, ſo viſible ideas and objects call up the ideas of words, and the actions by which they are pronounced.

Ninthly, The trains of viſible ideas are in a particular manner affected by the general ſtates of the brain, as may appear from the trains which preſent themſelves in madneſs, frenzies, and common deliriums. This agrees remarkably with what has been already obſerved concerning the ideas of this ſenſe; and we may infer from all together, that the regions of the brain correſponding to the optic nerve are comparatively large, or peculiarly ſuſceptive of impreſſions, or both.

Tenthly, The imagery of the eye ſympathizes alſo remarkably with the affections of the ſtomach. Thus the grateful impreſſions of opium upon the ſtomach raiſe up the ideas of gay colours, and tranſporting ſcenes, in the eye; and ſpaſms, and indigeſtions, have often a contrary effect. The ghaſtly faces which ſometimes appear in idea, particularly after drinking tea, ſeem to be an effect of this kind, or perhaps of the laſt-mentioned one; for they are common to perſons of irritable nervous ſyſtems. Ghaſtly faces may take place preferably to other diſagreeable ideas, perhaps becauſe characters, affections, paſſions, are principally denoted and expreſſed by the countenance; becauſe faces are the moſt common of viſible objects, and attended to with the greateſt earneſtneſs; becauſe we criticiſe much upon the beauty of faces, and upon the proportion of the ſeveral features to each other; and becauſe evil ſpirits (the notions of which generally take ſtrong and early poſſeſſion of our fancies) are painted with ghaſtly faces. This mixture of reaſons hinders each particular one from being ſo obvious, as might otherwiſe be expected; however, the ſame thing is common in many other caſes. The trains of viſible ideas, which occur in dreams, are deducible, partly from the ſympathy here mentioned, partly from that of the laſt paragraph.

Eleventhly, Our ſtock of viſible ideas may be conſidered as a key to a great part of our knowledge, and a principal ſource of invention in poetry, painting, mathematics, mechanics, and almoſt every other branch of the arts and ſciences. In mathematics and mechanics the invention of the diagram is, in effect, the ſolution of the problem. Our memories are alſo much aſſiſted by our viſible ideas in reſpect of paſt facts, and the preſervation of the order of time depends in a particular manner upon our viſible trains ſuggeſting each other in due ſucceſſion. Hence eye-witneſſes generally relate in order of time, without any expreſs deſign of doing ſo. This recollection of viſible ideas, in the order in which they were impreſſed, gives riſe to the *loci memoriales*, in which matters principally worthy of remembrance are to be repoſited, and to the artificial memory, that is borrowed from the eye; juſt as the facility of remembering words formed into verſes does to the artificial memory borrowed from the ear. It may deſerve notice here, that ſome perſons have imaginary places for the natural numbers, as far as one hundred, or farther.

Twelfthly, The ideas which different perſons have of the ſame perſons' faces, though they be very like one another, cannot yet be preciſely the ſame, on account of the addition and omiſſion of little circumſtances, and a variety of aſſociated ones, which intermix themſelves here. Hence the ſame picture may appear much more like to one perſon than to another, viz. according as it reſembles his idea more or leſs.

Thirteenthly, Painters, ſtatuaries, anatomiſts, architects, &c. ſee at once what is intended by a picture, draught, &c. from the perfection of their viſible ideas; and carry off the ſcene, plan, &c. in their memories, with quickneſs and facility. All which is ſtill owing to aſſociation. But it would be endleſs to enumerate the inſtances of aſſociations, which this ſenſe affords.

Fourteenthly, It is probable, that fables, parables, ſimiles, allegory, &c. pleaſe, ſtrike and inſtruct, chiefly on account of the viſible imagery, which they raiſe up in the fancy. They are alſo much more eaſily remembered on the ſame account. We may add, that idolatry, heatheniſh and popiſh, has made a much quicker and more extenſive progreſs in the world on account of the ſtability and vividneſs of viſible impreſſions and ideas, and the difficulty, obſcurity, and changeable nature, of abſtract notions. And image-worſhip ſeems even to have been derived in great meaſure from this ſource.

Fifteenthly, It would be a matter of great curioſity and uſe (as far as theſe ſpeculations can be of any uſe) to inquire carefully into the progreſs of the mind, and particularly of the fancy, in perſons born blind, and compare the reſult with what is advanced under this propoſition, and with other parts of theſe papers, in order to correct and improve the theory of aſſociation thereby. It is probable, that they are conſiderable loſers, upon the whole, in reſpect of knowledge; though their greater degree of attention, and the ſuperior acuteneſs of the ſenſes of feeling and hearing, and conſequently, perfection of the ideas of theſe ſenſes, muſt give them ſome particular advantages.

PROP. LXII.

To explain the automatic Motions, which are excited by Impreſſions made on the Eye.

These motions are of two kinds, external and internal. The external are the motions of the globe of the eye, thoſe of the eye-lids, and the contractions of the lacrymal, and other neighbouring glands, whereby they are evacuated. The internal are the contractions of the greater and leſſer muſcular rings of the *iris*, of the radiated fibres of the *iris*, and of the ciliar ligaments. I will ſpeak of each of theſe in order.

I begin with the motions of the globe of the eye. And here I obſerve, Firſt, That the white tendinous expanſions of the four ſtrait muſcles reach as far as the *cornea*; and conſequently, that they are thereby expoſed in a particular manner to the action of light, when the eye is open, being covered by nothing but a thin membrane. However, the tendinous expanſions of the *adducens* and *abducens* are much more expoſed than thoſe of the *attollens* and *deprimens*; and, if the eye be but a little open, the light cannot fall upon theſe laſt at all.

Secondly, If a luminous object be placed upon the right ſide, ſo as that the light ſhall fall in a particular manner upon the tendinous expanſion of the *abducens* of the right eye, and of the *adducens* of the left, it may by contracting theſe muſcles make the eyes move in a congruous manner, turning them towards itſelf; and the tendency of the eyes to move towards the right ſide ought not to ceaſe, till the *adducens* and *abducens* in each eye have an equal quantity of light fall upon them from the luminous object, *i. e.* till the optic axes be directed to it. In which caſe the eyes would be *in æquilibrio*, as far as they are under the influence of the light which falls upon the tendinous expanſions of the ſtrait muſcles.

Thirdly, It agrees remarkably with the two laſt paragraphs, that new-born children move their eyes in a congruous manner; that the motions are chiefly to the right and left, ſcarce upwards and downwards at all, the eye-lids being ſeldom ſo much opened as to expoſe the tendinous expanſions of the *attollens* and *deprimens*; and that their eyes are frequently turned towards luminous objects, ſuch as a candle, or a window.

Fourthly, But it is not neceſſary, that the eyes of new-born children ſhould always turn to the luminous object, or remain fixed upon it. For every muſcle, when it has exhauſted itſelf by contraction, gives place to its antagoniſt of courſe. If therefore the luminous object be much on one ſide, the eyes ought to turn back from it almoſt immediately. To which we may add, that various luminous objects generally affect the eyes at the ſame time; that the four ſtrait muſcles do naturally balance each other, and keep the eyes in a right forward poſition; and that the oblique muſcles ſcarce favour any particular oblique poſition, though they do prepare the eye to turn with greater facility, in compliance with the contraction of any one of the four ſtrait muſcles. There are therefore ſufficient ſources for a variety of motions in the globes of the eyes, without deſtroying their congruity.

Fifthly, It is worthy of attention here, that the *attollentes* and *deprimentes* do not want the ſame external influence of light to make them move in a congruous manner, as the *adducentes* and *abducentes*; in as much as one *adducens*, and one *abducens*, muſt act together, to make the eyes move congruouſly to the right and left; whereas the two *attollentes*, and two *deprimentes*, act together in the congruous motions upwards and downwards. As far therefore as the nerves of one ſide ſympathize with the correſponding nerves of the other in the influences which deſcend from the brain, there will be a natural tendency in the eyes to move upwards and downwards in a congruous manner, and to the right and left in an incongruous one. And this ſuits well with the greater expoſition of the tendinous expanſions of the *adducentes* and *abducentes* before taken notice of. For what reaſon ſo many pairs of nerves are concerned in the motions of the globe of the eye, and of the eye-lid, remains to be inquired.

Sixthly, It may perhaps be, that the light which paſſes in at the pupil has ſome efficacy in moving the globe of the eye, either by unknown communications in the brain between the optic nerve, and the third, fourth, and ſixth pairs, or perhaps by penetrating in a ſmall degree through the *retina*, *choroides*, and *ſclerotica*, to the four ſtrait muſcles. If this laſt influence could be allowed, it would oppoſe that exerted upon the tendinous expanſions; but would, however, join with it in preſerving the congruity of the motions.

Seventhly, As the two oblique muſcles neither have tendinous expanſions expoſed to the light, nor adhere to the globe of the eye, except juſt at their inſertion, they cannot be under either of the influences here ſuppoſed to affect the ſtrait muſcles, but muſt be ſubject chiefly to thoſe which deſcend from the brain; thus acting almoſt uniformly, unleſs in particular agitations of the whole nervous ſyſtem. And this agrees well with the fact, and with the uſes generally aſſigned to theſe muſcles, viz. thoſe of keeping the eye in a moderate ſuſpenſion always, and drawing it out on eminent occaſions.

Eighthly, The circumſtances which occaſion ſquinting in young children, agree well with the theory here propoſed. Thus, if a child be laid ſo into his cradle, as that one eye ſhall be covered, the external influences of light cannot operate upon it. And if this be often repeated, eſpecially while the aſſociation which confirms the congruity of the motions is weak, the eye which is covered will obey the influences which deſcend from the brain, and turn upwards and inwards for the moſt part. What turns the ſcale in favour of this poſition, remains to be inquired.

The ſecond of the external motions is that of the eye-lids, or the actions of the *elevator*, and *orbicularis palpebrarum*. What excites the firſt to conſtant action during the whole time that the new-born child is awake, is difficult to ſay. Perhaps the action of light upon the white of the eye, ſending vibrations under the upper eye-lid, and thence into the fibres of the *elevator:* or the direct action of light through the ſkin; for it is a cutaneous muſcle: or influences which deſcend into the third pair from the ſecond, *i. e.* the optic nerve: or the friction from the globe of the eye in its motions, which may alſo make the eye-lid ſympathize in motion with the eye: or the aggregate of all theſe. As to the *orbicularis,* it is evidently put into action by irritations affecting the eye, as from duſt, flies, &c. even in adults.

The third of the external motions, or the contraction of the lacrymal, and other neighbouring glands, ariſes from irritations in the eye, noſe, *fauces,* and ſcalp of the head. The manner in which theſe irritations operate, has been ſufficiently explained under *Prop.* 53.

Of the internal motions I will conſider the contraction of the greater and leſſer rings together, as proceeding from the ſame cauſes, and being cotemporaneous; and, for the ſame reaſons, the contraction of the radiated fibres, and ciliar ligament, together alſo. By the firſt the eye is fitted for diſtinct viſion at ſmall diſtances, by the other at great ones. Thus let us ſuppoſe a candle to be brought nearer and nearer to the child's eye. It is evident, that the quantity of light which falls upon the eye will grow greater and greater. It will therefore agitate all the circular fibres of the *iris* more powerfully, and particularly the greater and leſſer rings; *i. e.* it will bend the *cornea* into a greater convexity, bring the origin of the ciliar ligament nearer to its inſertion in the *capſula* of the cryſtalline, *i. e.* ſuffer the *capſula* to become more convex alſo, and narrow the pupil, *i. e.* leſſen the *radius* of diſſipation. The image of the candle upon the *retina* may therefore continue to be diſtinct, as it approaches, by this mechanical influence of light upon the eye. And, for the ſame reaſons, it may continue diſtinct, as it recedes. But there are limits on both hands. And thus the conformations of the eye neceſſary for diſtinct viſion, according to Dr. *Jurin*'s moſt accurate account of this matter, are brought about automatically, and ſuitably to the general theory of theſe papers.

However, it is alſo probable, that the light which paſſes in at the pupil, has great efficacy in contracting both the greater and leſſer rings, as may be concluded from the immobility of the pupil in a *gutta ſerena*; alſo becauſe, on this ſuppoſition, the light, which paſſes in at the pupil muſt, by contracting the leſſer ring, become a check and guard againſt its own too free admiſſion, which is agreeable to the tenor of nature in like inſtances. The *retina* extends to the greater ring, and may ſend ſome nervous fibres to it, and even to the *iris*.

One or both of theſe actions of light ſeem to increaſe the ſecretion and circulation of the aqueous humour in new-born children, ſo as to fit the eye for viſion, which it is not, through the deficiency and muddineſs of the aqueous humour, till ſome time after birth. This again may be conſidered as a circumſtance, that favours our preſent conjectures.

As to the radiated fibres of the *iris*, and the ciliar ligament, they do not ſeem ſo much to be excited to action by any external influence, as to be kept in a ſtate of conſtant ſmall activity by the vibrations which deſcend from the brain. When therefore the rings are relaxed, the radiated fibres will open the pupil, and the ciliar ligament draw out the *capſula* of the cryſtalline to a flatter ſhape, and thus ſuit the eye to obſcure and diſtant objects.

PROP. LXIII.

To explain the Manner and Degree, in which the automatic Motions, mentioned in the laſt Propoſition, are influenced by voluntary and ſemivoluntary Powers.

Since the motions of the eyes are in every inſtance congruous, from the inſtant of birth, an aſſociated tendency thereto is generated ſooner, and more firmly eſtabliſhed, than perhaps in any other caſe. As therefore the external influence of light by growing languid, comes to have leſs and leſs effect perpetually for this purpoſe, ſo the aſſociated tendency grows ſtronger and ſtronger; and the ſum total of both may perhaps be always about equal.

However, this congruity does not ſeem to be ſo great in children as in adults, who can direct their optic axes by a perfectly voluntary power to the object which they intend to view with attention. We muſt examine therefore, how the almoſt perfect congruity becomes an entirely perfect one.

Now here we are to obſerve, that the almoſt perfect congruity begets an almoſt perfect correſpondency in the points of the *retina*; and that hence it will follow by degrees, that the leaſt deviation from perfect congruity will occaſion double viſion, and confuſion. But theſe are unpleaſant and inconvenient, whereas ſingle and diſtinct viſion is pleaſant and convenient. Whence every recurrency of the laſt will tend to confirm it, of the firſt to exclude it, from principles already laid down, *Prop.* 22. *Cor.* 1. The child will therefore come to a perfect congruity at laſt, *i. e.* to direct his optic axes preciſely to the point which he intends to view. The voluntary power of ſuiting the internal motions to the diſtance muſt be ſuppoſed to grow perfect about the ſame time.

It agrees with this method of reaſoning, that perſons who loſe the ſight of one eye in their childhood or youth, though long after the external action of light has loſt its efficacy for making the motions congruous, generally ſquint a little with that eye.

The perſons who ſquint, preſerving the ſight of the ſquinting eye, are obliged to move their eyes in a congruous manner, for the ſame reaſon as others, viz. to avoid double viſion, though the poſition be incongruous.

The conſtant action of the *elevator palpebræ ſuperioris* in adults ſeems to be entirely from cuſtom, *i. e.* aſſociation, being kept up in a more particular manner by the variety of viſible objects, which engage our attention during the courſe of the day.

It is generally ſome time before children get the voluntary power of ſhutting the eyes gently, or of ſhutting one and not the other. They can ſhut them with force ſoon, this action recurring often from motes in the eyes, pain of any kind, &c. The procedure here is of the ſame kind as in other voluntary actions.

The internal motions depend originally upon the greater or leſs quantity of light which falls upon the *cornea* and *iris*, as has been obſerved already. But the nearneſs and remoteneſs of the luminous object are the reſpective aſſociates of theſe. The muſcular rings therefore, which at firſt contracted only when very luminous objects approached, will afterwards contract when moderately luminous ones do. And thus viſion will be made diſtinct in general. But diſtinct viſion, by recurring, will perpetuate and perfect itſelf, and indiſtinct check and aboliſh itſelf, from the agreeableneſs and diſagreeableneſs accompanying them reſpectively, by *Prop.* 22. *Cor.* 1. till at laſt the child gets a perfectly voluntary power of ſuiting his eyes to the diſtance. Adults ſeem to have a power of preparing the eyes previouſly to ſee at a propoſed diſtance; and ſome to have a ſemivoluntary power of contracting and dilating the pupil, viz. by fancying a bright object near, and a dark one far off; though the quantity of light which falls upon the eye remain the ſame.

SECT.

SECT. V.

OF THE SENSE OF HEARING.

PROP. LXIV.

To aſſign the immediate Organ of Hearing, and to explain in general the Uſes of the ſeveral Parts of the external and internal Ear.

THE immediate organ of hearing appears to be the ſoft portion of the ſeventh pair of nerves diſtributed in the *cochlea*, and ſemicircular canals. What the particular uſes of theſe cavities are, is not known. They bear ſome obſcure likeneſs to the inſtruments commonly made uſe of for increaſing either the loudneſs of ſounds, or the effects of them upon the ear; juſt as the coats and humours of the eye reſemble lenſes. The auditory nerve is alſo like the optic in detaching no branches off to the neighbouring parts; and there are many other inſtances of reſemblance between theſe two moſt refined and ſpiritual, if one may ſo ſay, of our ſenſes; ſome of which I ſhall mention in the courſe of this ſection.

The auricle and *meatus auditorius* are cartilaginous, and ſeem by this means to be peculiarly fitted for receiving and retaining the vibrations of the air, and for communicating them to the *membrana tympani.*

This membrane appears to be kept in a ſtate of conſtant tenſion by muſcles, that act upon the ſmall bones in different ways, and thus to be fitted for vibrating ſynchronouſly to the ſeveral ſounds, which affect it. Agreeably to which, the degree of tenſion varies, ſo as to be leſs when the *muſculus externus* and *obliquus* act, greater when theſe are relaxed, and the *internus* acts. The degree of ſenſibility both in the membrane itſelf, and in the whole organ, is probably greater when the tenſion is greater.

The vibrations of the air ſeem to ſhake off the *mucus* which lodges upon the *membrana tympani* in the new-born child juſt as the action of light fits the *cornea*, and aqueous humour, for viſion.

The euſtachian tube ſerves to ſupply the cavity of the *tympanum* with air, to carry off the vapour which exhales into it, and perhaps to increaſe the effects of ſounds by the tremors in its cartilaginous extremity, and particularly thoſe of the perſon's own voice.

The *ſtapes*, its muſcle, and the *foramen ovale*, ſeem deſigned to convey the vibrations of the *membrana tympani* to the auditory nerve in a preciſe manner. But the vibrations excited in its æther may be much more frequent than thoſe of the *membrana tympani*, as has been already obſerved.

There does not appear to be any method for conveying air into the cavities of the *veſtibulum*, *cochlea*, and ſemicircular canals, nor any neceſſity or uſe for it there. The great hardneſs of the bony part of the organ of hearing may make it more eaſily ſuſceptible of vibrations. Agreeably to which, it may be obſerved, that we can hear imperfectly, though the ears, noſe, and mouth, be all ſtopped, and conſequently all acceſs to the *membrana tympani* by the vibrations of the air denied. The vibrations are here excited probably in the cartilages of the auricle and *meatus*, and in the bones of the ſkull, and thus communicated to the *cochlea*, and ſemicircular canals. It ſeems to agree with this, that ſome partially deaf perſons can hear beſt, when driven in a coach over ſtones or gravel; *i. e.* when all the parts of their bodies, and particularly thoſe of the bones, are put into a vibrating motion.

The bony part of the organ of hearing ſeems to come to its full ſize early in life. Is not the final cauſe of this, that one part may, on account of its ſize, be moſt diſpoſed to vibrate with one tone, another with another? And does not this hold particularly in reſpect of the *lamina ſpiralis?* For thus the ſame tone would be affixed and aſſociated to the ſame nerves, ſo as to affect them peculiarly, from childhood or youth to old age.

PROP. LXV.

To examine how far the Phænomena of muſical and other inarticulate Sounds are agreeable to the Doctrine of Vibrations.

Here we may conſider, firſt, the different ſtrength of ſounds. Now, as this ariſes from the different condenſation of the air in the pulſes, ſo the effect which it has upon the *membrana tympani*, the membrane of the *foramen ovale*, and the nerves of hearing, muſt be different likewiſe, and afford the mind a ſufficient foundation for diſtinguiſhing ſounds in reſpect of ſtrength and feebleneſs.

Secondly, The gravity and acuteneſs of ſounds ariſe from the ſlowneſs or frequency of the vibrations. Now, as the vibrations of the *membrana tympani* are ſynchronous to thoſe of the air, they may either excite ſynchronous ones in the particles of the auditory nerves, and thus be diſtinguiſhed from each other in reſpect of frequency by the mind; or if every pulſe of the air, and oſcillation of the *membrana tympani*, excite innumerable infiniteſimal vibrations in the auditory nerves, the renewal of theſe at different intervals according to the different gravity or acuteneſs of the ſound will, however, afford a like criterion.

It may be remarked, that grave ſounds are in general ſtrong, acute ones feeble. For the bodies which yield grave ſounds are in general large, and conſequently will make an impreſſion upon the air by a large number of trembling particles.

Thirdly, All very loud noiſes are diſagreeable. Now it is eaſy to conceive, that very violent agitations of the *membrana tympani* may produce the ſolution of continuity in the ſmall medullary particles of the auditory nerve. An inflammation in the ſmall veſſels of the auditory nerve may render it ſo ſuſceptible of violent vibrations, as to be hurt by gentle ſounds, as ſometimes happens in diſtempers; and to produce that acuteneſs in the ſenſe of hearing, which anſwers to the *nyctalopia* in the eye.

Fourthly, Single muſical, *i. e.* uniform ſounds, whether vocal or inſtrumental, are pleaſant in proportion to their loudneſs, provided this be not exceſſive. We muſt therefore ſuppoſe here, that the repeated impulſes of the air, at equal diſtances, make the vibrations approach to the ſolution of continuity; yet ſtill ſo as to fall ſhort of it.

Fifthly, Two muſical notes ſounded together, ſuppoſe upon an organ or violin, afford a greater original pleaſure than one, provided the ratios of their vibrations be ſufficiently ſimple. Thus any note ſounded with its eighth, fifth, fourth, third major or minor, ſixth major or minor, affords pleaſure, the ratios being here, reſpectively, thoſe of 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 3 to 5, and 5 to 8, which are all very ſimple ones. But a note with its flat or ſharp, ſecond, or ſeventh, or flat fifth, is originally diſagreeable. It may be obſerved alſo, that concords ſeem to be originally pleaſant in proportion to the ſimplicity of the ratios by which they are expreſſed, *i. e.* in the order above ſet down. Hence we may perhaps ſuſpect, that even the concords were originally unpleaſant to the ear of the child, from the irregularity of the vibrations which they impreſs upon the *membrana tympani*, and conſequent ſolution of continuity; and that they fell at laſt within the limits of pleaſure, as many other pains do, by repetition. For thus thoſe concords in which the ratios are ſimpleſt would become pleaſant firſt, and the others would continue to excite pain, or to border upon it. It is agreeable to this, that diſcords become at laſt pleaſant to the ears of thoſe that are much converſant in muſic, and that the too frequent recurrency of concords cloys.

Sixthly, Concords ſounded in ſucceſſion ſeem to have the ſame effect, in kind, upon the ear, as when ſounded together, only leſs in degree. But diſcords in ſucceſſion do not offend, unleſs the chromatic ſucceſſion of half notes, or ſome ſuch remarkable ones, and even theſe pleaſe at laſt. All this follows eaſily from the laſt paragraph; and the preſent paragraph, with the two laſt, taken together, contain the principal grounds of the natural and original pleaſures of muſic. The pleaſures which it derives from aſſociation will be conſidered hereafter.

PROP. LXVI.

To examine how far the Judgments which we make concerning the Diſtance and Poſition of the ſounding Body, are agreeable to the Doctrine of Aſſociation.

Sounds ought to decreaſe in the reciprocal duplicate ratio of the diſtance, did they not receive ſome ſupport from the reflection of the bodies over which they paſs. This makes them decreaſe in a leſs ratio; however, they do decreaſe in general with the diſtance; and this decreaſe, being an aſſociate of the increaſe of diſtance, ought to ſuggeſt it to the imagination. And, agreeably to this, we may obſerve, that, when the wind oppoſes the ſound of bells, they appear farther off; when a perſon calls through a ſpeaking trumpet, he appears nearer, than at the true diſtance.

As to the poſition of the ſounding body, we have no clear or certain criterion, unleſs it be very near us; ſo as that the pulſes may ſtrike one ear, or one part of the head, conſiderably ſtronger than another. Hence we judge of the poſition of the ſpeaker, or ſounding body, by the eye, or by ſome other method independent on the ear. And thus, if from ſome miſtaken preſumption a voice, or ſound, ſhall be deemed to come from a quarter different from the true place of it, we ſhall continue in that error from the ſtrength of that miſtaken preſumption.

By laying theſe things together, and alſo conſidering farther, that indiſtinctneſs in articulate ſounds is an aſſociated mark of diſtance, we may ſee how *ventriloqui*, or perſons that ſpeak in their throats, without moving their lips, impoſe upon the audience. Their voice is faint and indiſtinct, and therefore appears to come from a more diſtant quarter than the ſpeaker. The hearers look about therefore, and, being ſurprized, their imagination fixes ſtrongly upon that corner, or cavity, which appears moſt plauſible; and afterwards they continue to impoſe upon themſelves by the ſtrength of this prejudice.

PROP. LXVII.

To examine how far the Power of diſtinguiſhing articulate Sounds depends upon the Power of Aſſociation.

ONE may ſuppoſe the external and internal ear to be ſo formed, as that all the differences in the vibrations of the air, which arrive at the ear, may affect the auditory nerves with correſponding differences. Let us therefore firſt conſider in what manner different ſounds impreſs different vibrations upon the air.

Firſt, then, Since not only the parts about the throat, but thoſe of the mouth, cheeks, and even of the whole body, eſpecially of the bones, vibrate in ſpeaking, the figure of the vibrations impreſſed upon the air by the human voice will be different from that of the vibrations proceeding from a violin, flute, &c. provided the diſtance be not too great. This therefore may be conſidered as one help for diſtinguiſhing articulate ſounds from all others.

Secondly, Articulation conſiſts in breaking out from a whiſper into ſound, or cloſing the ſound in different manners, the organs of ſpeech being put alſo into different ſhapes, ſo as to join the differences mentioned in the laſt paragraph with various eruptions and interruptions, aſcents and deſcents of ſound. And thus each letter may be diſtinguiſhed from every other by hearing.

Thirdly, It is agreeable to all this, that it is difficult at great diſtances to diſtinguiſh the tone of one muſical inſtrument from another, or of any from the tone of a human voice, *cæteris paribus*; or to diſtinguiſh articulate ſounds from one another. For at great diſtances the vibrations of the air are circular to ſenſe, and all the aſcents, deſcents, eruptions and interruptions of ſound, which diſtinguiſh one compound ſound from another, are confounded by numberleſs reflections from the intermediate bodies.

Fourthly, We may obſerve, that as the preſerving the diſtinction of place is the chief end of the coats and humours in the organ of ſight, ſo the diſtinction of time is of the greateſt importance in hearing. It ſeems probable therefore, that the *membrana tympani*, ſmall bones, and their muſcles, are ſo contrived, as by their actions to preſerve the diſtinction of time, *i. e.* to extinguiſh ſtrong ſounds, and to keep up weak ones, ſo as that the laſt may not be too much overpowered by the continuance of the firſt; juſt as the treble notes of a harpſichord would be by the baſs ones, did not the bits of cloth affixed to the jacks check the vibrations of the ſtrings in due time.

Having now ſhewn how articulate ſounds may be diſtinguiſhed from one another, and from all other ſounds; I next obſerve, that, in fact, the ſpeakers do not pronounce ſo articulately and diſtinctly in common converſation, as to furniſh the hearers with the requiſite criterions according to the foregoing theory; but that we arrive at a facility of underſtanding one another's diſcourſe, chiefly by the power of aſſociation.

And, firſt, It is needleſs to pronounce every letter ſo as to diſtinguiſh it from all others. For then words, which are compoſed of letters, would each have as many criterions as they have letters, and even more; for the order of the letters is a criterion, as well as the ſound of each letter. In like manner, ſentences would have as many compound criterions as they have words, beſides the criterion ariſing from the particular order of the words.

Secondly, Since words are formed from combinations, not according to any rule, which brings up all the combinations of twos, threes, &c. in order, but by particular aſſociations, agreeably to the nature of each language, ſince alſo ſentences are formed in the ſame way, the ſeveral component parts of words and ſentences ſuggeſt each other, and alſo the whole words and ſentences by the power of aſſociation. Thus the beginning is commonly obſerved to ſuggeſt the whole, both in words and ſentences; and the ſame is true, in a leſs degree, of the middles and ends.

Thirdly, The ſubject matter of the diſcourſe, the geſtures uſed in ſpeaking, a familiar acquaintance with the particular voice, pronunciation, geſtures, &c. of the ſpeaker, and other aſſociated circumſtances contribute greatly alſo. And therefore, on the other hand, we find it difficult to diſtinguiſh proper names, and the words of an unknown language, and to underſtand a perſon that is a ſtranger, or that uſes no action.

We may ſee alſo, that it is chiefly by the means of aſſociated circumſtances, that the ſounds uttered by *ventriloqui* ſuggeſt to us the words, which they are ſuppoſed to pronounce; for their articulations muſt be very incomplete, as they do not move their lips at all.

It is by a like ſet of aſſociated circumſtances that we are enabled to read with ſo much facility the irregular hand-writing of various perſons, and of ſome more than others, in proportion as we are better acquainted with the ſubject, language, hand-writing, &c.

PROP. LXVIII.

The Doctrine of Sounds illuſtrates and favours that of the Vibrations of the ſmall medullary Particles of the Brain, and nervous Syſtem.

For the theory of ſounds deduced from the nature of an elaſtic fluid, and the tremors of the particles of ſounding bodies, and afterwards verified, as it has been, by numerous experiments, becomes a guide to us in all inquiries into the vibrations of other elaſtic mediums, ſuch as the æther, and into the effects, which ſuch vibrations muſt impart to and receive from the ſmall particles, that are ſurrounded by the elaſtic medium. And the general tendency which is found in natural bodies, either to yield a ſound upon percuſſion, or at leaſt to ſupport and convey ſounds by receiving iſochronous vibrations, and reflecting them, ſhews, that there are latent active powers, in the ſmall parts of bodies, which diſpoſe them to vibrate. Now, if there be ſuch powers in the biggeſt component particles, analogy inclines one to expect them in the ſeveral deſcending orders.

The doctrine of ſounds does alſo furniſh us with an anſwer to one of the principal and moſt obvious difficulties attending the ſuppoſition, that all ſenſation, thought, and motion, is performed by vibrations in the medullary ſubſtance. For it may be objected, that ſuch a number of different vibrations, as ſeems to be required in certain caſes, can ſcarce exiſt together in the medullary ſubſtance. Thus it is not uncommon for a perſon to receive a ſeries of ſenſations, carry on a train of thought, and perform a courſe of external actions, which have little connection with each other, at the ſame time. Now to this we may anſwer, that vibrations as different from each other do, in fact, exiſt together in common air, in ſuch a manner as to be perceived diſtinctly. Thus a perſon may liſten to what part he pleaſes in a concert of muſic, and maſters in the art can liſten to more than one. They can alſo at the ſame time receive, attend to, and underſtand the vibrations of the air, ariſing from the diſcourſe of other perſons. But in whatever manner theſe different vibrations can exiſt together preciſely at the ſame inſtant, or rather ſucceed each other at infiniteſimal intervals, without confuſion; in the ſame manner may vibrations and vibratiuncles exiſt together, or ſucceed each other, without confuſion alſo, in the medullary ſubſtance: and by whatever power the ſoul is qualified to attend to, and diſtinguiſh from each other, theſe ſeveral vibrations of the air, by the ſame power may it correſpond to the vibrations in the medullary ſubſtance, ſo that each ſhall have its peculiar effect of producing the appropriated ſenſation, thought, and motion. It is to be obſerved farther, that there is a difficulty in performing both the things here mentioned; that confuſion does often ariſe; and that where any perſon is remarkable for doing more than one thing at once, it is in conſequence of great practice, and alſo of exquiſite mental powers, *i. e.* of an exquiſite make of the medullary ſubſtance, according to the theory of theſe papers.

PROP. LXIX.

To explain in what Manner, and to what Degree, agreeable and diſagreeable Sounds contribute, in the Way of Aſſociation, to the Formation of our intellectual Pleaſures and Pains.

As all moderate and tolerably uniform ſounds pleaſe young children, and the original pleaſures from concords ſounded together, from the ſucceſſion of both concords and diſcords, and even from clear, muſical ſounds, conſidered ſeparately, remain with us through the whole progreſs of life, it is evident, that many of our intellectual pleaſures muſt be illuminated and augmented by them. And, on the contrary, harſh, irregular, and violently loud noiſes muſt add ſomething to the diſagreeableneſs of the objects and ideas, with which they are often aſſociated.

The pleaſures of muſic are compoſed, as has been already obſerved, partly of the original, corporeal pleaſures of ſound, and partly of aſſociated ones. When theſe pleaſures are arrived at tolerable perfection, and the ſeveral compounding parts cemented ſufficiently by aſſociation, they are transferred back again upon a great variety of objects and ideas, and diffuſe joy, good-will, anger, compaſſion, ſorrow, melancholy, &c. upon the various ſcenes and events of life; and ſo on reciprocally without perceptible limits.

The corporeal pleaſures from articulate ſounds are either evaneſcent from the firſt, or, however, become ſo very early in life. By this means we are much better qualified to receive information, with mental pleaſure and improvement, from them; and the ear becomes, like the eye, a method of perception ſuited to the wants of a ſpiritual being. And indeed when we compare the imperfections of ſuch as have never heard, with thoſe of perſons that have never ſeen, it appears, that the ear is of much more importance to us, conſidered as ſpiritual beings, than the eye. This is chiefly owing to the great uſe and neceſſity of words for the improvement of our knowledge, and enlargement of our affections; of which I ſhall have particular occaſion to treat hereafter. An accurate inquiry into the mental progreſs of perſons deprived of the advantages of language, by being born deaf, would be a ſtill better teſt of the theory of theſe papers, than a like inquiry concerning perſons born blind.

PROP. LXX.

To give an Account of the Ideas generated by audible Impreſſions.

The ideas which audible impreſſions leave in the region of the brain, that correſponds to the auditory nerves, are, next to the ideas of ſight, the moſt vivid and definite of any; and all the obſervations above made upon the ideas of ſight may be applied to thoſe of hearing, proper changes and allowances being made. Thus, after hearing muſic, converſing much with the ſame perſon, in general diſorders of the brain, or particular ones of the nervous ſpaſmodic kind in the ſtomach, after taking opium, in dreams, in madneſs, trains of audible ideas force themſelves upon the fancy, in nearly the ſame manner, as trains of viſible ideas do in like caſes. And it may be, that in paſſing over words with our eye, in viewing objects, in thinking, and particularly in writing and ſpeaking, faint miniatures of the ſounds of words paſs over the ear. I even ſuſpect, that, in ſpeaking, theſe miniatures are the aſſociated circumſtances which excite the action, be it voluntary, or ſecondarily automatic. For children learn to ſpeak chiefly by repeating the ſounds which they hear, *i. e.* theſe ſounds are the aſſociated circumſtances, which excite to action. But if the ſound does this, the idea of it muſt get the ſame power by degrees. I grant indeed, that the pictures of words in the eye, and their ideas, may be like aſſociated circumſtances, exciting to ſpeak; and ſince it is neceſſary, according to the theory of theſe papers, that every ſemivoluntary, voluntary, and ſecondarily automatic action, ſhould be excited by an aſſociated circumſtance, one may reckon words ſeen, and their viſible ideas, amongſt the number of ſuch circumſtances. But words heard, and their audible ideas, have a prior claim; and, in perſons that cannot read or write, almoſt the only one. It confirms this, that in writing one is often apt to miſ-ſpell in conformity with the pronunciation, as in writing *hear* for *here*; for this may proceed from the audible idea, which is the ſame in both caſes; cannot from the viſible one. Where a perſon miſ-ſpells ſuitable to a miſpronunciation, which ſometimes happens, it can ſcarce be accounted for upon other principles. However, in writing, the aſſociated circumſtance, which excites the action of the hand, is moſt probably the viſible idea of the word, not the audible one.

If it be objected to the ſuppoſition of theſe audible trains, that we ought to be conſcious of them, I anſwer, that we are in ſome caſes; which is an argument, that they take place in all, in a leſs degree; that the greater vividneſs of the viſible trains makes us not attend to, or recollect them, till the conſciouſneſs or memory be vaniſhed; and that even viſible trains do not appear as objects of conſciouſneſs and memory, till we begin to attend to them, and watch the evaneſcent perceptions of our minds.

The ideas of ſight and hearing together are the principal ſtorehouſe of the fancy or imagination;

and the imaginative arts of painting and muſic ſtand in the ſame relation to them reſpectively. Poetry comprehends both by taking in language, which is the general repreſentative of all our ideas and affections.

As there is an artificial memory relative to the eye, by which trains of viſible ideas, laid up in the memory in a certain order, are made to ſuggeſt both things themſelves, and the order in which we deſire to remember them; ſo compendious trains of technical words formed into verſes may be made to ſuggeſt other words, alſo the numeral figures in a certain order; and, by this means, to bring to view, at pleaſure, the principles and materials of knowledge for meditation, inquiry, and more perfect digeſtion by the mind, as appears from Dr. *Grey*'s *Memoria Technica*. The viſible *loci* make a ſtronger impreſſion on the fancy, and therefore excel the audible ones in that view; but the audible ones have a much more ready and definite connection with the things to be remembered; and therefore ſeem moſt proper, upon the whole, in moſt branches of literature. And as Dr. *Grey*'s method is highly uſeful in general, ſo it is particularly excellent in reſpect of all memorables that are repreſented by numeral figures. For, when the numeral figures are denoted by letters, collections of them, ſuch as dates, and quantities of all kinds, make ſhort and definite impreſſions upon the ear; which are not only eaſy to be remembered, but alſo preſerve the order of the figures without danger of error: whereas neither the impreſſions which collections of figures make upon the eye, nor thoſe which their enunciations in words at length make upon the ear, can be remembered with facility or preciſion; becauſe neither figures, nor their names, cohere together, ſo as that the precedent ſhall ſuggeſt the ſubſequent; as the letters do in collections of them, capable of being pronounced. When the technical word coincides with, or approaches to, a familiar one, it is remembered with greater facility. Aſſociation is every where conſpicuous in theſe things.

PROP. LXXI.

To explain the automatic Motions, which are excited by Impreſſions made on the Ear.

It does not appear at all improbable, that the vibrations, which are excited by ſounds in the cartilages of the auricle and *meatus auditorius,* ſhould paſs into the ſmall muſcles of the auricle, and there occaſion automatic motions. And I gueſs in particular, that in very loud ſounds, the cartilages would be made to lie cloſer to the head. But the ſmallneſs of theſe muſcles, and the practice of binding down the ears of new-born children cloſe to the head, which reſtrains the natural action of theſe muſcles, whatever it be, prevent our making any certain judgment.

As to the four muſcles which belong to the ſmall bones, it appears to me, that ſince the *externus* and *obliquus* lie out of the *tympanum,* expoſed to the common air, and are alſo ſo ſituated, that the *externus* may receive vibrations from the cartilage of the *meatus auditorius,* the *obliquus* from the cartilage of the *proceſſus ravianus,* into which it is inſerted, they muſt be much more affected by loud ſounds, than the *internus* or *muſculus ſtapedis.* It follows therefore, that the *membrana tympani* will be relaxed automatically by loud ſounds. Here therefore is another remarkable coincidence between efficient and final cauſes.

For what reaſons the *muſculus internus,* and *muſculus ſtapedis,* may act peculiarly in weak ſounds, is difficult to ſay. They may perhaps, as was above conjectured of the radiated fibres of the *iris,* depend chiefly on the influences which deſcend from the brain, and therefore act always, when the other two will give them leave. It is moſt probable, that the four muſcles act in various proportions and combinations, ſo as to anſwer a variety of purpoſes. But there is very little, that is ſatisfactory, to be met with in books of anatomy and phyſiology hitherto, concerning the peculiar minute uſes and functions of the ſeveral parts of the organ of hearing.

PROP. LXXII.

To explain the Manner and Degree, in which the automatic Motions, mentioned in the laſt Propoſition, are influenced by voluntary and ſemivoluntary Powers.

SINCE grave ſounds are in general loud, acute ones weak, the relaxation of the *membrana tympani*, which firſt attends upon loud ſounds automatically, will afterwards by aſſociation, be made to attend upon grave ones, even though they are not loud; and, in like manner, the membrane will be tenſe from acute ſounds, though they ſhould be ſtrong; *i. e.* the membrane will, by aſſociation, be fitted to vibrate iſochronouſly with the ſeveral tones; juſt as the convexity of the *cornea* is made by aſſociation to ſuit itſelf to the ſeveral diſtances. The accommodation is at firſt groſs in both caſes; but is perfected afterwards from the view of pleaſure and convenience, by means of the frequent recurrency of the actions. See *Prop.* 22. *Cor.* 1.

We ſeem alſo to have a voluntary power of preparing the ear previouſly for very ſtrong, or very weak ſounds, which we expect to hear, juſt as it was before obſerved of the eye, that we can ſuit it previouſly to ſee at an expected diſtance. The generation of theſe powers is the ſame, as that of the other voluntary ones.

SECT. VI.

OF THE DESIRES OF THE SEXES TOWARDS EACH OTHER.

PROP. LXXIII.

To examine how far the Deſires of the Sexes towards each other are of a factitious Nature, and deducible from the Theory of theſe Papers.

HERE we are to obſerve, firſt, That when a general pleaſurable ſtate is introduced into the body, either by direct impreſſions, or by aſſociated influences, the organs of generation muſt ſympathize with this general ſtate, for the ſame reaſons as the other parts do. They muſt therefore be affected with vibrations in their nerves, which riſe above indifference into the limits of pleaſure from youth, health, grateful aliment, the pleaſures of imagination, ambition, and ſympathy, or any other cauſe, which diffuſes grateful vibrations over the whole ſyſtem.

Secondly, As theſe organs are endued with a greater degree of ſenſibility than the other parts, from their make, and the peculiar ſtructure and diſpoſition of their nerves, whatever theſe be, we may expect, that they ſhould be more affected by theſe general pleaſurable ſtates of the nervous ſyſtem than the other parts.

Thirdly, The diſtention of the cells of the *veſiculæ ſeminales*, and of the *ſinuſes* of the *uterus*, which take place about the time of puberty, muſt make theſe organs more particularly irritable then. It may perhaps be, that the acrimony of the urine and *fæces*, which make vivid impreſſions on the neighbouring parts, have alſo a ſhare in increaſing the irritability of the organs of generation.

Fourthly, Young perſons hear and read numberleſs things in this degenerate and corrupt ſtate of human life, which carry nervous influences of the pleaſurable kind (be they vibrations, or any other ſpecies of motion) to the organs of generation. This will be better underſtood, if the reader pleaſes to recollect what was delivered above concerning the methods, by which we learn to diſtinguiſh the ſenſations of the parts external and internal from each other. For it will be eaſy to ſee, that when we are once arrived at this power, the aſſociated circumſtances of any ſenſations, ſuch as the language that relates to them, will recal the ideas of theſe ſenſations.

Fifthly, The particular ſhame which regards the organs of generation, may, when conſidered as an aſſociated circumſtance, like other pains, be ſo far diminiſhed as to fall within the limits of pleaſure, and add conſiderably to the ſum total.

Sixthly, The ſources here pointed out ſeem ſufficient to account for the general deſires, which are obſervable in young perſons; and which, when not allowed and indulged, may be conſidered as within the confines of virtue.

Seventhly, It is uſual for theſe deſires, after ſome time, to fix upon a particular object, on account of the apprehended beauty of the perſon, or perfection of the mind, alſo from mutual obligations, or marks of affection, from more frequent intercourſes, &c. after which theſe deſires ſuggeſt, and are ſuggeſted by, the idea of the beloved perſon, and all its aſſociates, reciprocally and indefinitely, ſo as in ſome caſes to engroſs the whole fancy and mind. However, this particular attachment, when under proper reſtrictions and regulations, is not only within the confines of virtue, but often the parent of the moſt diſintereſted, and pure, and exalted kinds of it.

Eighthly, When theſe deſires are gratified, the idea of the beloved perſon, and its aſſociates, muſt now be aſſociated with the ſtate of neutrality and indifference, that ſucceeds after gratification. Whence it appears, that that part of the affection towards the beloved perſon, which ariſes from groſs animal cauſes, cannot remain long at its height, and may fall very faſt. However, if the other ſources of affection grow ſtronger, the ſum total may continue the ſame, or even increaſe.

Ninthly, When impure deſires are allowed, indulged, and heightened voluntarily, it is evident from the doctrine of aſſociation, that they will draw to themſelves all the other pleaſures of our nature, and even by adhering to many neutral circumſtances, convert them into incentives and temptations. So that all the deſires, deſigns, and ideas of ſuch perſons are tainted with luſt. However, the diſeaſes and ſufferings, bodily and mental, which this vice brings upon men, do, after ſome time, often check the exorbitancy of it, ſtill in the way of aſſociation. But impure deſires ſubſiſt, like vicious ones of other kinds, long after the pains outweigh the pleaſures, inaſmuch as they muſt be ſuppoſed not to begin to decline till the pains apprehended to ariſe from them, and thus aſſociated with them, become equal to the pleaſures.

Tenthly, It appears from the courſe of reaſoning here uſed, that impure and vicious deſires, indulged and heightened voluntarily, can by no means conſiſt with a particular attachment and confinement; alſo that they muſt not only end frequently in indifference but even in hatred and abhorrence. For the proper mental ſources of affection are not only wanting in theſe caſes, but many diſpleaſing and odious qualities and diſpoſitions of mind muſt offer themſelves to view by degrees.

Eleventhly, As the deſires and pleaſures of this kind are thus increaſed by aſſociated influences from other parts of our natures, ſo they are reflected back by innumerable aſſociated methods, direct and indirect, upon the various incidents and events of life, ſo as to affect in ſecondary ways even thoſe who have never experienced the groſs corporeal gratification. And, notwithſtanding the great and public miſchiefs, which ariſe from the ungovernable deſires of the vicious, there is great reaſon, even from this theory, to apprehend, that, if this ſource of the benevolent affections was cut off, all other circumſtances remaining the ſame, mankind would become much more ſelfiſh and malicious, much more wicked and miſerable upon the whole, than they now are.

Twelfthly, I have hitherto chiefly conſidered how far the preſent ſubject is agreeable to the doctrine of aſſociation, but, if phyſicians and anatomiſts will compare the circumſtances of the ſenſations and motions of theſe organs with the general theory delivered in the firſt chapter, they may ſee conſiderable evidences for ſenſory vibrations, for their running along membranes, and affecting the neighbouring muſcles in a particular manner: they may ſee alſo, that muſcular contractions, which are nearly automatic at firſt, become afterwards ſubject to the influence of ideas.

Thirteenthly, The theory here propoſed for explaining the nature and growth of theſe deſires ſhews in every ſtep, how watchful every perſon, who deſires true chaſtity and purity of heart, ought to be over his thoughts, his diſcourſes, his ſtudies, and his intercourſes with the world in general, and with the other ſex in particular. There is no ſecurity but in flight, in turning our minds from all the aſſociated circumſtances, and begetting a new train of thoughts and deſires, by an honeſt, virtuous, religious attention to the duty of the time and place. To which muſt be added great abſtinence in diet, and bodily labour, if required.

SECT. VII.

OF OTHER MOTIONS, AUTOMATIC AND VOLUNTARY, NOT CONSIDERED IN THE FOREGOING SECTIONS OF THIS CHAPTER.

PROP. LXXIV.

To examine how far the Motions of the Heart, ordinary and extraordinary, are agreeable to the Theory of theſe Papers.

HERE I obſerve,

Firſt, That the motion of the heart is conſtant, more equable than any other in the body, and cannot be ſuppoſed to proceed from impreſſions made on the neighbouring parts; which things agree well together upon the ſuppoſition of the doctrine of vibrations: for thus it cannot proceed from the firſt or fourth ſource of motory vibrations; and if it proceeds from the ſecond and third, it ought to be conſtant, and nearly equable.

Secondly, We are not to inquire, how the heart is firſt put into motion in the fœtus, but only how its ordinary motions may be continued, by means of vibrations deſcending from the brain, after they are once begun.

Now, for this purpoſe, let us ſuppoſe, that the auricles, with the beginnings of the pulmonary artery and aorta, have finiſhed their contractions; and that the ventricles and coronary veſſels are full. It follows, that the ventricles will now be excited to contraction by three cauſes, viz. by the vibrations which have continued to deſcend freely into their fibres, ever ſince their laſt contraction was finiſhed, by their diſtention from fulneſs, and by the motion and impulſe of the blood in the coronary veſſels: but from the moment that the ventricles begin to contract, the auricles and arteries will begin to fill, and will be fulleſt at the inſtant when their contraction is finiſhed. The auricles and arteries muſt therefore begin to contract at this inſtant, from deſcending vibrations and diſtention, and the ventricles to be relaxed and filled, the vibrations in their fibres being checked by their paſt contraction. Let theſe actions be completed, and the heart will be in the circumſtances firſt ſuppoſed, *i. e.* the ventricles will be ready for a freſh contraction, and ſo on alternately, as long as life continues.

Thirdly, The vibrations which keep up the heart's motion, are nearly allied to thoſe ariſing from heat; for the ſecond ſource of motory vibrations is the reſidue of all the vibrations excited in the various parts of the body; and the third ariſes chiefly from the heat of the blood. We may expect therefore, that the heart ſhould contract either more frequently, or more ſtrongly, or both, when the body is heated. And thus it is, as may appear from obſervations upon the pulſe in fevers, in ſleep, after eating, in pains or diſtempers attended with an increaſe of heat, &c. in which the motion of the blood is increaſed; whereas in nervous pains attended with coldneſs of the extremities, the pulſe is low and ſlow.

Fourthly, In the declenſion of fevers the pulſe is quick and feeble. It is feeble, becauſe the whole body is ſo; and quick, partly from the new habit ſuperinduced by the heat in the beginning of the fever; partly, becauſe in fevers the heart is always kept nearly full, *i. e.* nearly at ſuch a degree of diſtention as incites it to contraction, the principal cauſes of which are the weakneſs and inactivity of the body: hence in general the pulſe is quick and feeble in perſons of relaxed habits; the contrary in ſtrong ones.

Fifthly, The pulſe is quick in young and ſmall animals; ſlow in old and large ones. For this, various reaſons may be aſſigned; as firſt, that if the velocity wherewith the ſides of the heart move towards each other be the ſame, the contraction muſt be ſooner accompliſhed in ſmall hearts than in large ones. Secondly, that the fibres in young animals are irritable; and ſoon excited to contraction, by diſtention, &c. Thirdly, that the contraction is performed ſlowly in old animals; and, fourthly, that ſhort fibres are perhaps ſooner excited to contraction than long ones, it being neceſſary perhaps, that the vibrations ſhould be reverberated from each end of the fibres, for many ſucceſſions before they can riſe to a certain pitch. It agrees with this, that reciprocal motions are more frequent in general, and *cæteris manentibus*, as the animal is leſs; that the limbs have both long and ſhort flexors and extenſors, the firſt for great degrees of motion, the laſt for making a quick beginning; that the capſular ligaments of the joints have ſhort muſcular fibres inſerted into them, in order to keep them from being pinched between the bones in the motions of the joints, as *Winſlow* has obſerved; which they could not do, had not their contraction the ſtart of the contractions which move the joint; and, laſtly, that the fibres which compoſe the heart, are all of equal lengths, according to Dr. *Stewart*'s analyſis of them. See *Phil. Tranſ. n.* 460.

Sixthly, The heart may move inceſſantly without fatigue, if we only ſuppoſe the recruits to be ſufficient, and the degree of motion to be within due limits. And it may be, that in labouring men the muſcles of the limbs are as much exerted upon the whole as the heart. The warmth in which the heart is kept, and its receiving nerves from the eighth pair and intercoſtal, which ſeem to be particularly exempted from venal compreſſion, deſerve notice here: but the conſtant motion of the blood is principally to be conſidered, being the cauſe as well as the effect of the conſtant motion of the heart.

Seventhly, Since lying down prevents or alleviates the fainting which ſometimes happens during bleeding, one may ſuppoſe that this fainting, and the conſequent abatement or ceſſation of the motion of the heart ariſe, becauſe a quantity of blood, ſufficient to keep up the vibrations in the brain, could not aſcend thither in an erect poſture.

Eighthly, Sudden and violent pains, ſuch as thoſe from wounds increaſe the motion of the heart. This may be accounted for from the violent vibrations which aſcend to the brain, and are thence propagated to the heart. But may not vibrations aſcend alſo directly from the wounded part, along the courſe of the arteries and veins, to the heart?

Ninthly, All the paſſions of the mind increaſe the motion of the heart, as might be expected: but melancholy, when it makes men inactive, and uninfluenced by the impreſſions of objects, has a contrary effect, which is equally ſuitable to the foregoing theory.

Tenthly, In mortifications, alſo in the languid ſtate that ſucceeds acute diſtempers, &c. the pulſe ſometimes intermits, ſuppoſe once in 5, 10, 20, &c. times, the interval being about double, and the ſtrength of the pulſe which ſucceeds the intermiſſion about double alſo. Here the force of the heart ſeems to languiſh, and the time of contraction of the ventricle to be protracted, till a ſecond contraction of the auricle intervenes, and protracts the ventricle's contraction ſtill farther, viz. to nearly twice the interval. The heart muſt therefore be ſurcharged, and contracting ſtronger from this reſpite, muſt ſend, as it were, a double quantity of blood into the aorta, *i. e.* make the pulſe that ſucceeds much ſtronger. And this intermiſſion may return at greater or leſs intervals, according to the circumſtances, while this weakneſs of the heart continues: it may alſo remain, when once eſtabliſhed, from habit, or aſſociation.

This intermiſſion may perhaps rather be accounted for thus: in languid ſtates the blood is accumulated in the beginning of the aorta. The aorta will not therefore receive much blood from the heart, though it does contract, *i. e.* no pulſe will be felt, *i. e.* the interval will be double: the ſucceeding pulſe will be ſtrong, from the now greater emptineſs of the aorta, and fulneſs of the heart: the intermiſſion will alſo return when the accumulation in the aorta does. It agrees with this account, that theſe intermiſſions are uſually felt in the region of the heart by the patients. May not intermiſſions ariſe from both cauſes in different circumſtances?

Eleventhly, When the pulſe flutters from flatulencies and ſpaſms in the ſtomach and bowels, it appears that a ſudden ſtop is put to the blood of the aorta, which by ſurcharging the left ventricle at once, makes it contract at a different time from the right, and not at a due interval from the contraction of the auricles: for this fluttering of the pulſe attacks generally in an inſtant, and often upon a fruitleſs effort to expel wind from the ſtomach. When the contractions of the ventricles are once become aſynchronous and inharmonious to thoſe of the auricles, it may require ſome time to rectify this, and eſpecially while there is an impediment to the blood's motion through the aorta. This diſorder may likewiſe continue through habit and aſſociation, and recur perpetually from leſs and leſs cauſes. The intermiſſion of the pulſe, conſidered in the two preceding paragraphs, is often cauſed by flatulencies, as well as the fluttering of it, mentioned in this.

Twelfthly, The motions of the heart remain in their original automatic ſtate more than any other in the body; the reaſons of which are, that the common motions are equally aſſociated with every thing, *i. e.* peculiarly ſo with nothing; and that very few impreſſions make changes in the motions of the heart ſo great and ſudden, as to ſubject it to the ideas of theſe impreſſions: however, as great and ſudden changes are ſometimes brought on by pain, fear, ſurprize, joy, &c. we ſeem to have a ſemivoluntary power to alter the motion of the heart immediately, by introducing ſtrong ideas, our power of introducing theſe being ſemivoluntary: nay, it may be poſſible for perſons in very particular circumſtances to acquire ſtill greater degrees of power over the motion of the heart.

PROP. LXXV.

To examine how far the Action of Reſpiration, ordinary and extraordinary, alſo the particular Actions of Sighing, Coughing, Laughter, Sobbing, and ſhedding Tears from Grief, are agreeable to the foregoing Theory.

THE firſt obſervation to be made here is, that common reſpiration is performed very feebly in new-born children. A ſlight diſpoſition therefore to alternate action in the diaphragm, and other muſcles of reſpiration, may be ſufficient to account for that degree of reſpiration which takes place in new-born children. It is natural to expect, that reſpiration in them ſhould be feeble, ſince they muſt lean in this, as well as in other things, to their preceding ſtate *in utero*.

Secondly, That the vigorous impreſſions from the cold air, the hands of the midwife, &c. may excite the ſtrong reſpiration and crying which take place upon birth ordinarily, appears from the methods uſed to make the new-born child reſpire freely, where it fails to do this in extraordinary caſes; ſuch as applying volatiles to the noſe, pouring wine into the mouth, ſwinging it to and fro, &c. All theſe methods excite the muſcles to contraction, by making ſtrong impreſſions on the neighbouring ſenſory nerves.

They are alſo very agreeable to the notion of vibrations.

Thirdly, If we ſuppoſe the diaphragm to have finiſhed its contraction, and conſequently the thorax to be raiſed, and the abdomen to be diſtended, expiration muſt ſucceed, for three reaſons, viz. becauſe the contraction of the diaphragm has checked the vibrations in its fibres, and therefore has diſpoſed them to relaxation; becauſe the elaſticity of the cartilages of the ribs tends to reſtore the thorax to a more depreſſed ſtate; and becauſe the fibres of the abdominal muſcles are excited to vibrations and contraction by their diſtention. Suppoſe now expiration to be completed, and the vibrations, which deſcend into the diaphragm from the ſecond and third ſource of motory vibrations, will renew its contraction, and conſequently the action of inſpiration; and ſo on alternately.

Fourthly, The diaphragm is the more diſpoſed to receive vivid vibrations in its fibres, from its nearneſs to the heart, and the warmth in which it is always kept. It deſerves notice here, that the diaphragm receives its nerves from the cervical pairs, not from the eighth pair and intercoſtal, as the neighbouring parts, the heart, ſtomach, &c. do. Perhaps it was requiſite, that it ſhould derive its nerves from the ſpinal marrow, ſince the other muſcles of reſpiration do. The nerves of the diaphragm are elongated during its contraction, the contrary to which happens in the nerves of other muſcles. They are alſo kept in conſtant motion by the conſtant motion of the thorax, through which they paſs; and this perhaps may contribute to the perpetual activity of the diaphragm.

Fifthly, The intercoſtal muſcles are diſpoſed to alternate contractions for the ſame reaſons as the diaphragm, though theſe reaſons do not hold in the ſame degree: However, ſince the contraction of the diaphragm, and conſequent diſtention of the abdomen, muſt raiſe the thorax, the contraction of the intercoſtal muſcles muſt from the firſt be ſynchronous to that of the diaphragm; and aſſociation will ſoon generate a permanent diſpoſition to this ſynchroniſm. It follows according to this theory from the vicinity of the internal intercoſtal muſcles to the external ones, that they ought to have the ſame action. And the ſame concluſion appears to reſult from anatomical conſiderations.

Sixthly, It may however be ſuppoſed, that the diaphragm and intercoſtal muſcles are, as it were, fatigued by conſtant action; and that they incline to ſympathize in inactivity with the reſt of the muſcles, eſpecially during ſleep. But then the accumulation of blood in the lungs, which the intermiſſion of reſpiration muſt occaſion, after it has once had a free paſſage through the lungs, by means of reſpiration, will produce ſo much uneaſineſs, *i. e.* ſuch vigorous vibrations, in the lungs, and particularly in their external membrane, which is continuous to the pleura, as will renew reſpiration.

It is agreeable to this, that if very young children ſleep upon a bed, they often fall into a great uneaſineſs from the ſtoppage of reſpiration, and recover from it by crying; and that rocking, or any other gentle motion, will prevent this. The laſt circumſtance is particularly favourable to the notion of vibrations.

The night-mare in adults appears to be a diſorder of the ſame kind. A full ſupper, and lying upon the back, diſpoſe to it, by hindering the free motion of the diaphragm. Motion, and eſpecially when attended with quick reſpiration, laughter, &c. prevent it by giving activity to the diaphragm. Shaking the perſon affected, calling to him, &c. rouſe from it, by exciting vibrations. The uneaſineſs from accumulated blood does the ſame thing at laſt.

It is eaſy to ſee, that if a like diſpoſition to inaction ſhould ariſe in the hearts of new-born children, or adults, the motion and diſtending force of the venal blood muſt renew their action for ſimilar reaſons. It is remarkably coincident with this, that forcing the venal blood upon the heart has in ſome caſes been found to renew its action even after death.

Seventhly, The actions of ſighing, crying, coughing, ſneezing, &c. by recurring frequently, and making all the muſcles, which can in any degree contribute to reſpiration, unite therein, enlarge the range of reſpiration by degrees, and make this action be performed with greater ſtrength perpetually in the young child. The increaſe of ſtrength in the whole muſcular ſyſtem muſt however be conſidered likewiſe.

Eighthly, The ſame actions have alſo a great ſhare in begetting voluntary reſpiration. For more muſcles are put into action in voluntary reſpiration, than in that which is ordinary.

Ninthly, it is agreeable to the foregoing theory, and to parallel obſervations on the heart, that reſpiration ſhould be ſtronger in fevers, in ſleep, and in general wherever the heat of the blood is increaſed, than in ordinary caſes. For reſpiration depends chiefly on the ſecond and third ſources of motory vibrations. By this means the force of the reſpirations anſwers in a general way, as it ought to do, to the force with which the blood is moved, or to the force of the heart.

I now come to the particular conſideration of the actions of ſighing, coughing, laughter, and ſobbing, and ſhedding tears from grief.

Sighing is an extraordinary contraction of the diaphragm. It ariſes not only from all cauſes, which accumulate the blood in the lungs, and thus excite the diaphragm to an extraordinary contraction; but alſo from ſuch compreſſions of the *abdomen* as hinder the free motion of the diaphragm for a time. For thus a diſpoſition to vibrate is accumulated in the fibres of the diaphragm. It is however to be obſerved, that this compreſſion of the *abdomen* does alſo accumulate blood in the lungs. The *abdomen* ſeems to be compreſſed in a ſtate of ſorrow, attention, &c. The frequent recurrency of ſighing makes it voluntary early in youth. But it is not performed voluntarily with the ſame force, as when from a preſſing uneaſineſs in the lungs.

Coughing ariſes from an uneaſy ſenſation in the wind-pipe fixing in the point of the *epiglottis*, as the ſenſation which cauſes ſneezing does in the tip of the noſe. This ought alſo to become voluntary, and to be weaker when voluntary, than when excited by a ſtrong irritation.

Hawking is a voluntary action, derived from coughing, as blowing the noſe is from ſneezing. Spitting is nearly related to theſe actions. It tallies perfectly with the foregoing theory, that children cannot hawk, ſpit, or blow the noſe, for ſome years.

Laughter is a naſcent cry, recurring again and again, as has been obſerved before, *Prop.* 26. By degrees it puts on a certain type, and recurs again and again according to that type, juſt as other actions. And it is excited in young children not only by the ſenſation of tickling, which lies, as it were, between pleaſure and pain, but by the apprehenſion of this, or any other apprehenſion ſufficiently moderate, by every ſurprize, and every mental emotion that lies between pleaſure and pain, and by all the aſſociates of theſe, as particularly by ſeeing others laugh. And thus children laugh more and more, and get a power of performing the action of laughter at pleaſure, though with leſs force than when it is excited by its proper cauſe in full vigour.

It is remarkable, that young brute creatures, in their ſportings with each other, make ſuch noiſes, as bear the ſame analogy to their violent cries, which laughter in us bears to crying from pain.

Bodily pain is attended with violent and irregular reſpiration on account of the violent and irregular vibrations, which, in this caſe, firſt aſcend to the brain, and then deſcend into the diaphragm. Hence mental pain, which is the offspring of bodily pain, is attended alſo with violent and irregular reſpiration, *i. e.* with ſobbing. The crying which uſed to attend bodily pain in childhood is often checked in the mental pains of adults by fear, ſhame, &c. *i. e.* by a voluntary or ſemivoluntary power; and this ſeems to make the reſpiration ſo much the more irregular.

It is more difficult to account for the ſhedding tears from grief; for very young children are not apt to ſhed tears when they cry. It ſeems to me, that ſo great and general a diſorder in the brain, as that which takes place in violent grief, muſt affect the fifth pair of nerves in a particular manner, ſo as to influence the lachrymal glands both directly, and alſo indirectly, viz. by the ſtrong convulſions produced in the muſcles of the eyes and face. The membrane of the *fauces* and noſe are likewiſe affected in grief, as is evident from the ſenſations in the *fauces*, and tip of the noſe; and thus vibrations may run to the lachrymal glands through the *ductus ad naſum*, and lachrymal points, as obſerved before in irritations from ſternutatories, &c. Young children may not ſhed tears freely, becauſe very great and general diſorders of the brain, and its influence over the fifth pair of nerves, do not take place till intellectual aggregates are formed. And the like reaſon may hold in reſpect of brutes.

The actions of ſobbing and weeping are therefore, in part, deducible from aſſociation, *i. e.* are not merely automatic, in the firſt ſenſe of that word. Agreeably to which, they are in certain caſes manifeſtly ſubject to the voluntary power. Thus, ſome perſons can, by introducing imaginary ſcenes of compaſſion

paſſion and ſorrow, ſo far agitate the brain, as to bring on the actions of ſobbing and weeping, though not in the ſame degree, as when they ariſe from a ſtrong real mental cauſe. They may likewiſe be caught by infection, from others, as laughter, and moſt of our other ſemivoluntary and voluntary actions, are; which is another argument of their dependence on aſſociation.

PROP. LXXVI.

To examine how far convulſive Motions of various Kinds, and the Actions of Yawning and Stretching in particular, are agreeable to the foregoing Theory.

SINCE ſtrong vibrations muſt, according to the foregoing theory, deſcend at once into the whole muſcular ſyſtem in general convulſions, we muſt ſeek for a cauſe of ſufficient extent for this purpoſe. Now there ſeem to be three kinds of vibrations, which may anſwer this condition: firſt, violent vibrations in the brain. Secondly, violent ones at the ſkin, ſuddenly checked. Thirdly, violent ones in the bowels or *uterus*, ſuddenly checked alſo, and thence running inſtantaneouſly over the whole nervous ſyſtem by means of the intercoſtal, or as *Winſlow* juſtly calls it, the great ſympathetic nerve.

Convulſions from compreſſions and inflammations of the brain, and moſt of thoſe which are termed epileptic, ſeem to be of the firſt kind. In epilepſies the irregular vibrations, excited in the medullary ſubſtance of the brain are perhaps ſo violent, as firſt to make the ſmall particles attract each other, and thus, by checking themſelves, to extinguiſh all ſenſe and motion. However, they may return after a ſhort time, and deſcend into the whole muſcular ſyſtem.

The ſtretchings and yawnings which happen in ague-fits, in going to ſleep and waking, the ſtartings to which ſome perſons are ſubject in going to ſleep, and the convulſive tremors, and rigidity in ague-fits, ſeem to be of the ſecond kind, or to ariſe from a ſudden check of vibrations at the ſkin. For in agues the ſurface is chilled, as it is alſo by the leaſt motions in going to ſleep, or waking. Agreeably to this, it may be obſerved, that, upon ſtepping into a cold bed, one is diſpoſed to general convulſions, like thoſe of ſtretching. Yawning may alſo depend in part upon a like check of violent vibrations in the mouth and *fauces*; for it is a motion excited in the neighbourhood, and is obſerved to accompany ſickneſs.

The ſtartings and convulſions which happen to children from gripes, to women from diſorders of the *uterus*, and to all perſons in general from certain poiſons, ſeem to be of the third kind, or to ariſe from vigorous vibrations in the *abdomen*, ſuddenly checked, and running into the whole ſyſtem by means of the intercoſtal nerve.

It has been obſerved already, that convulſive motions are apt to return from leſs and leſs cauſes perpetually, on account of the veſtiges which they leave of themſelves, and the power of aſſociated circumſtances. I will add here, that ſeeing a perſon in convulſions is apt to occaſion them in ſuch as are of nervous and irritable frames; and that there is reaſon to believe, that ſome perſons, who have been enthuſiaſts or impoſtors, have been able to throw themſelves into convulſions by a ſemivoluntary power, and particularly, as it ſeems, by introducing ſtrong ideas, and internal feelings.

It is commonly obſerved, that yawning is apt to infect a whole company, after one perſon in it has ſet the example; which is a manifeſt inſtance of the influence of aſſociation over motions originally automatic.

PROP. LXXVII.

To examine how far the Motions, that are moſt perfectly voluntary, ſuch as thoſe of Walking, Handling, and Speaking, with the voluntary Power of ſuſpending them, and their being formed according to Patterns ſet by thoſe with whom we converſe, are agreeable to the foregoing Theory.

It was neceſſary to deliver many things which properly relate to this propoſition under the twenty-firſt, in order to make the derivation of voluntary motion from automatic, by means of aſſociation, in ſome meaſure intelligible to the reader. I will now reſume the ſubject, and add what I am able for the full explication and eſtabliſhment of the theory propoſed.

Walking is the moſt ſimple of the three kinds of voluntary motion here mentioned, being common to the brute creation with man, whereas handling and ſpeaking are, in a manner, peculiar to him. His ſuperiority in this reſpect, when compared with the ſuperiority of his mental faculties, agrees well with the hypotheſis here advanced concerning handling and ſpeaking, viz. their dependence on ideas, and the power of aſſociation.

The new-born child is unable to walk on account of the want of ſtrength to ſupport his body, as well as of complex and decomplex motory vibratiuncles, generated by aſſociation, and depending upon ſenſations and ideas by aſſociation alſo. As he gets ſtrength, he advances likewiſe in the number and variety of compound motions of the limbs, their ſpecies being determined by the nature of the articulations, the poſition of the muſcles, the automatic motions excited by friction, accidental flexures and extenſions made by the nurſe, &c. When he is tolerably perfect in theſe rudiments of walking, the view of a favourite plaything will excite various motions in the limbs; and thus if he be ſet upon his legs, and his body carried forward by the nurſe, an imperfect attempt to walk follows of courſe. It is made more perfect gradually by his improvement in the rudiments, by the nurſe's moving his legs alternately in the proper manner, by his deſire of going up to perſons, playthings, &c. and thence repeating the proceſs which has ſucceeded (for he makes innumerable trials, both ſucceſsful and unſucceſsful); and by his ſeeing others walk, and endeavouring to imitate them.

It deſerves notice here, that in the limbs, where the motions are moſt perfectly voluntary, all the muſcles have antagoniſts, and often ſuch as are of nearly equal ſtrength with themſelves; alſo, that the muſcles of the limbs are not much influenced at firſt by common impreſſions made on the ſkin, and ſcarce at all when the child is ſo far advanced as to get a voluntary power over them. For theſe things facilitate the generation of the voluntary power, by making the muſcles of the limbs chiefly dependent on the vibrations which deſcend from the brain, and alſo diſpoſing them to act from a ſmall balance in favour of this or that ſet of antagoniſts.

When the child can walk up to an object that he deſires to walk up to, the action may be termed voluntary, *i. e.* the uſe of language will then juſtify this appellation. But it appears from the reaſoning here uſed, that this kind and degree of voluntary power over his motions is generated by proper combinations and aſſociations of the automatic motions, agreeably to the corollaries of the twentieth propoſition. Voluntary powers may therefore reſult from aſſociation, as is aſſerted in theſe papers.

When he is arrived at ſuch a perfection in walking, as to walk readily upon being deſired by another perſon, the action is eſteemed ſtill more voluntary. One reaſon of which is, that the child, in ſome caſes, does not walk when deſired, whilſt yet the circumſtances are apparently the ſame as when he does. For here the unapparent cauſe of walking, or not walking, is *will.* However, it follows from this theory, that all this is ſtill owing to aſſociation, or to ſomething equally ſuitable to the foregoing theory; *e. g.* to the then preſent ſtrength or weakneſs of the aſſociation of the words of the command with the action of walking, to its proceeding from this or that perſon, in this or that manner, to the child's being in an active or inactive ſtate, attentive or inattentive, diſpoſed by other circumſtances to move as directed, or to move in a different way, &c. A careful obſervation of the fact will always ſhew, as far as is reaſonable to be expected in ſo nice a matter, that when children do different things, the real circumſtances, natural or aſſociated, are proportionably different, and that the ſtate of mind called *will* depends upon this difference. This degree of voluntary power is therefore, in like manner, of an acquired nature.

Suppoſe an adult to walk, in order to ſhew his perfectly voluntary power; ſtill his ſelecting this inſtance is owing to one aſſociation, and his performing the action to another, viz. to the introduction of the audible idea of the word, the viſible one of the action, &c.

Walking paſſes into the ſecondarily automatic ſtate more perfectly perhaps, than any other action; for adults ſeldom exert any degree of volition here, ſufficient to affect the power of conſciouſneſs or memory for the leaſt perceptible moment of time. Now this tranſition of walking, from its voluntary to its ſecondarily automatic ſtate, muſt be acknowledged by all to proceed merely from aſſociation. And it ſeems to follow by parity of reaſon, that the tranſition

tion of primarily automatic actions into voluntary ones may be merely from aſſociation alſo, ſince it is evident, that aſſociation has at leaſt a very great and extenſive influence there.

The complex artificial motions of the lower limbs, uſed in the ſeveral kinds of dancing, bear nearly the ſame relation to the common motions uſed in walking forwards, backwards, upwards, downwards, and ſideways, as theſe common motions do to the ſimple rudiments above-mentioned, ſuch as the flection and extenſion of the ancle or knee. Since therefore the voluntary and ſecondarily automatic power of dancing are plainly the reſult of aſſociation, why may we not ſuppoſe the ſame of the common motions in walking, both in their voluntary and ſecondarily automatic ſtate? In learning to dance, the ſcholar deſires to look at his feet and legs, in order to judge by ſeeing, when they are in a proper poſition. By degrees he learns to judge of this by feeling; but the viſible idea left partly by the view of his maſter's motions, partly by that of his own, ſeems to be the chief aſſociated circumſtance, that introduces the proper motions. By farther degrees theſe are connected with each other, with the muſic, and with other more and more remote circumſtances.

I have already ſhewn, in what manner children learn the voluntary and ſecondarily automatic power of graſping. How they learn the various complex motions, by which they feed and dreſs themſelves, &c. alſo how children and adults learn to write, to practiſe manual arts, &c. and in what ſenſes and degrees all theſe actions are voluntary, and ſecondarily automatic, and yet ſtill remain as purely mechanical, as the primarily automatic actions are, may now be underſtood from what has been already delivered under this propoſition. The method of playing upon muſical inſtruments has alſo been explained, ſo as to concur in eſtabliſhing the ſame concluſions.

In like manner, the account given of the action of ſpeaking might now be completed, and extended to all the modes of it, vulgar and artificial; and to ſinging, with its modes. I will add a few words concerning ſtammering, and the loſs of ſpeech by palſies.

Stammering ſeems generally to ariſe from fear, eagerneſs, or ſome violent paſſion, which prevents the child's articulating rightly, by the confuſion which it makes in the vibrations that deſcend into the muſcular ſyſtem; ſo that, finding himſelf wrong, he attempts again and again, till he hits upon the true ſound. It does not begin therefore in general, till children are of an age to diſtinguiſh right from wrong in reſpect of pronunciation, and to articulate with tolerable propriety. A nervous diſorder of the muſcles of ſpeech may have a like effect. When the trick of ſtammering has once begun to take place in a few words, it will extend itſelf to more and more from very ſlight reſemblances, and particularly to all the firſt words of ſentences, becauſe there the organs paſs in an inſtant from inactivity to action; whereas the ſubſequent parts of words and ſentences may follow the foregoing from aſſociation; juſt as, in repeating *memoriter*, one is moſt apt to heſitate at the firſt word in each ſentence.

A defect of memory from paſſion, natural weakneſs, &c. ſo that the proper word does not occur readily, occaſions ſtammering alſo. And, like all other modes of ſpeaking, it is caught, in ſome caſes, by imitation.

A palſy of the organs of ſpeech may be occaſioned in the ſame manner as any other palſy; and yet the muſcles of the lips, cheeks, tongue, and *fauces*, may ſtill continue to perform the actions of maſtication and deglutition ſufficiently well, becauſe theſe actions are ſimpler than that of ſpeech, and are alſo excited by ſenſations, which have an original influence over them.

A defect of memory may alſo deſtroy the power of ſpeaking, in great meaſure, though the organs be not much affected in a paralytical way. Thus a perſon who plays well upon a harpſichord, may by ſome years diſuſe become unable to play at all, though the muſcles of his hands be in a perfect ſtate, merely becauſe his memory, and the aſſociations of the motions of his fingers with the ſight of notes, with the ideas of ſounds, or with one another, are obliterated by diſtance of time, and diſuſe.

The ſuſpenſion of an action may be performed two ways, as before-mentioned, viz. either by putting the muſcles concerned in it into a languid inactive ſtate, or by making the antagoniſts act with vigour. In the firſt caſe, the whole limb is put into a ſtate of relaxation, and extreme flexibility; in the laſt, into a ſtate of rigidity. The voluntary power of the firſt kind is obtained by aſſociations with the languor that ariſes from fatigue, heat, ſleepineſs, &c. that of the laſt from the general tenſion of the muſcles, which happens in pain, and violent emotions of mind. Children improve in both theſe kinds of voluntary power by repeated trials, as occaſion requires, by imitation, deſire, &c. But they are both difficult for ſome time. Thus we may obſerve, that children cannot let their heads or eye-lids fall from their mere weight, nor ſtop themſelves in running or ſtriking, till a conſiderable time after they can raiſe the head, or bend it, open the eyes, or ſhut them, run or ſtrike by a voluntary power.

Imitation is a great ſource of the voluntary power, and makes all the ſeveral modes of walking handling, and ſpeaking, conformable to thoſe of the age and nation in which a perſon lives in general, and to thoſe of the perſons with whom he converſes in particular. Beſides the two ſources already mentioned, *Prop.* 21. viz. the ſight of the child's own actions, and the ſound of his own words, it has many others. Some of theſe are the reſemblance which children obſerve between their own bodies, with all the functions of them, and thoſe of others; the pleaſures which they experience in and by means of all motions, *i. e.* imitations; the directions and encouragements given to them upon this head; the high opinions which they form, of the power and happineſs of adults; and their conſequent deſire to reſemble them in theſe, and in all their aſſociates. Imitation begins in the ſeveral kinds of voluntary actions about the ſame time, and increaſes not only by the ſources alleged, but alſo by the mutual influences of every inſtance of it over every other, ſo that the velocity of its growth is greatly accelerated for ſome time. It is of the higheſt uſe to children in their attainment of accompliſhments, bodily and mental. And thus every thing, to which mankind have a natural tendency, is learnt much ſooner in ſociety, than the mere natural tendency would beget it; and many things are learnt ſo early, and fixed ſo deeply, as to appear parts of our nature, though they be mere derivatives and acquiſitions.

It is remarkable, that apes, whoſe bodies reſemble the human body, more than thoſe of any other brute creature, and whoſe intellects alſo approach nearer to ours, which laſt circumſtance may, I ſuppoſe, have ſome connection with the firſt, ſhould likewiſe reſemble us ſo much in the faculty of imitation. Their aptneſs in handling is plainly the reſult of the ſhape and make of their fore legs, and their intellects together, as in us. Their peculiar chattering may perhaps be ſome attempt towards ſpeech, to which they cannot attain, partly from the defect in the organs, partly, and that chiefly, from the narrowneſs of their memories, apprehenſions, and aſſociations; for they ſeem not to underſtand words to any conſiderable degree. Or may not their chattering be an imitation of laughter?

Parrots appear to have far leſs intellect than apes, but a more diſtinguiſhing ear, and, like other birds, a much greater command of the muſcles of the throat. Their talk ſeems to be almoſt devoid of all proper connection with ideas. However, in reſpect of ſounds, they imitate as much as children, or as apes in reſpect of other actions. And indeed the talk of children, by out-running their underſtandings in many things, very much reſembles that of parrots.

As we expreſs our inward ſentiments by words, ſo we do alſo by geſtures, and particularly by the muſcles of the face. Here, again, aſſociation and imitation diſplay themſelves. This dumb ſhew prevails more in the hotter climates, where the paſſions are more impetuous, than in theſe northern ones. It is alſo probable, that the narrowneſs and imperfection of the ancient languages made it more neceſſary and prevalent in ancient times. Deaf perſons have an extraordinary aptneſs both in learning and decyphering this, as might well be expected. The imitation of manners and characters by dumb ſhew is often more ſtriking, than any verbal deſcription of them.

SECT. VIII.

OF THE RELATION WHICH THE FOREGOING THEORY BEARS TO THE ART OF PHYSIC.

PROP. LXXVIII.

The Art of Phyſic affords many proper Teſts of the Doctrines of Vibrations and Aſſociation; and may receive conſiderable Improvement from them, if they be true.

THIS propoſition may appear from ſeveral hints to that purpoſe, which have been already given.

But it will be more fully manifeſt, if I give a ſhort view of the *data* and *quæſita* in the art of phyſic.

Now the general problem, which comprehends the whole art, is,

Having the ſymptoms given, to find the remedy.

This problem may be ſolved in ſome caſes empirically and directly by the hiſtories of diſtempers, and of their cures. But then there are other caſes, and thoſe not a few, to which the learning and experience of the moſt able phyſicians either cannot find hiſtories ſufficiently ſimilar, or none where the event was ſucceſsful. Hence it is neceſſary to attempt the ſolution of the general problem rationally and indirectly, by dividing it into the two following leſs comprehenſive and conſequently more manageable problems, viz.

Firſt, *Having the ſymptoms given, to find the deviation of the body from its natural ſtate.*

Secondly, *Having this deviation given, to find the remedy.*

It is proper alſo to invert theſe two problems, and to inquire, firſt, *Having the deviation given, what the ſymptoms muſt be.*

Secondly, *Having the manner of operation of a ſucceſsful remedy given, what the deviation muſt be.*

I here uſe the words *ſymptoms*, *deviation*, and *remedy*, in the moſt general ſenſe poſſible, for the ſake of brevity.

Now it is very evident, that the doctrine of vibrations, or ſome other better doctrine, which teaches the law of action of the nervous ſyſtem, has a cloſe connection with all theſe laſt four problems. For the nerves enter every part, as well as the blood veſſels; and the brain has as great a ſhare in all the natural functions of the parts, and its diſorders, in all their diſorders, as the heart, and its diſorders, can have; and much more than any other part, beſides the heart.

Farther, If the doctrine of aſſociation be the neceſſary conſequence of the doctrine of vibrations, in any ſuch manner as I have propoſed above, *Prop.* 9. and 11. it muſt have a moſt intimate connection with the theory of nervous diſtempers, and ſome with that of others, on account of the juſt mentioned dependence of all the parts on the brain. Or, if we ſeparate theſe doctrines, ſtill, if that of aſſociation be true, of which I ſuppoſe there is no doubt, it cannot but be of great uſe for explaining thoſe diſtempers in which the mind is affected.

And it ſeems to me, that, agreeably to this, the diſtempers of the head, ſpaſmodic ones, the effects of poiſonous bites and ſtings, which. as Dr. *Mead* juſtly obſerves, are more exerted upon the nerves than on the blood, receive much light from the doctrine of vibrations, and, in return, confirm it; and that all the diſorders of the memory, fancy, and mind, do the ſame in reſpect of the doctrine of aſſociation.

I do not mean to intimate here, that the rational and indireſt ſolution of the general problem, which comprehends the art of phyſic, is preferable to the empirical and direct one, where this is to be had; but only, ſince this cannot be had always, that we ought to proceed in an explicit and ſcientifical manner, rather than in a confuſed and popular one. For where practice is ſilent, phyſicians muſt and will have recourſe to ſome theory, good or bad. And if they do not acquaint themſelves with the real ſtructure and functions of the parts, with the ſenſible qualities and operations of medicines, and with the moſt probable method of explaining both the ſymptoms of diſtempers, and the operations of medicines, they muſt fancy ſomething in the place of theſe, and reaſon from ſuch falſe imaginations, or perhaps from the mere agreements, oppoſitions, and ſecondary ideas, of Words. The hiſtory of diſeaſes, and their cures, is the baſis of all; after this come anatomical examinations of the body, both in its natural and morbid ſtates; and, laſt of all, pharmacy; theſe three anſwering reſpectively to the general problem, and the two ſubordinate ones abovementioned. And if we reaſon at all upon the functions and diſorders of the parts, and the effects of medicines upon the body, ſo important an organ as the brain muſt not be left out entirely.

It may not be amiſs to add here, that as all the natural functions tend to the welfare of the body, ſo there is a remarkable tendency in all the diſorders of the body to rectify themſelves. Theſe two tendencies, taken together, make what is called nature by phyſicians; and the ſeveral inſtances of them, with their limits, dangers, ill conſequences, and deviations in particular caſes, deſerve the higheſt attention from phyſicians, that ſo they may neither interrupt a favourable criſis, nor concur with a fatal one. *Stahl* and his followers ſuppoſe, that theſe tendencies ariſe from a rational agent preſiding over the fabric of the body, and producing effects, that are not ſubject to the laws of mechaniſm. But this is *gratis dictum*; and the plain traces of mechaniſm, which appear in ſo many inſtances, natural and morbid, are highly unfavourable to it. And all the evidences for the mechanical nature of the body or mind are ſo many encouragements to ſtudy them faithfully and diligently, ſince what is mechanical *may* both be underſtood and remedied.

CHAP. III.

Containing a particular APPLICATION *of the foregoing* THEORY *to the* PHÆNOMENA *of* IDEAS, *or of* UNDERSTANDING, AFFECTION, MEMORY, *and* IMAGINATION.

SECT. I.

OF WORDS AND THE IDEAS ASSOCIATED WITH THEM.

PROP. LXXIX.

Words and Phraſes muſt excite ideas in us by Aſſociation, and they excite Ideas in us by no other Means.

WORDS may be conſidered in four lights.

Firſt, As impreſſions made upon the ear.

Secondly, As the actions of the organs of ſpeech.

Thirdly, As Impreſſions made upon the eye by characters.

Fourthly, As the actions of the hand in writing.

We learn the uſe of them in the order here ſet down. For children firſt get an imperfect knowledge of the meaning of the words of others; then learn to ſpeak themſelves; then to read; and, laſtly, to write.

Now it is evident, that in the firſt of theſe ways many ſenſible impreſſions, and internal feelings, are aſſociated with particular words and phraſes, ſo as to give theſe the power of raiſing the correſponding ideas; and that the three following ways increaſe and improve this power, with ſome additions to, and variations of the ideas. The ſecond is the reverſe of the firſt; and the fourth of the third. The firſt aſcertains the ideas belonging to words and phraſes in a groſs manner, according to their uſage in common life. The ſecond fixes this, and makes it ready and accurate; having the ſame uſe here as the ſolution of the inverſe problem has in other caſes in reſpect of the direct one. The third has the ſame effect as the ſecond; and alſo extends the ideas and ſignifications of words and phraſes, by new aſſociations; and particularly by aſſociations with other words, as in definitions, deſcriptions, &c. The advancement of the arts and ſciences is chiefly carried on by the new ſignifications given to words in this third way. The fourth, by converting the reader into a writer, helps him to be expert in diſtinguiſhing, quick in recollecting, and faithful in retaining, theſe new ſignifications of words being the inverſe of the third method, as juſt now remarked. The reader will eaſily ſee, that the action of the hand is not an eſſential in this fourth method. Compoſition by perſons born blind has nearly the ſame effect. I mention it as being the common attendant upon compoſition, as having a conſiderable uſe deducible from aſſociation, and as making the analogy between the four methods more conſpicuous and complete.

This may ſuffice for the preſent, to prove the firſt part of the propoſition, viz. that words and phraſes muſt excite ideas in us by aſſociation. The ſecond part, or that they excite ideas in us by no other means, may appear at the ſame time, as it may be found upon reflection and examination, that all the ideas which any word does excite are deducible from ſome of the four ſources above-mentioned, moſt commonly from the firſt or third.

It may appear alſo from the inſtances of the words of unknown languages, terms of art not yet explained, barbarous words. &c. of which we either have no ideas, or only ſuch as ſome fancied reſemblance, or prior aſſociation, ſuggeſts.

It is highly worthy of remark here, that articulate ſounds are by their variety, number, and ready uſe, particularly ſuited to ſignify and ſuggeſt, by aſſociation, both our ſimple ideas, and the complex ones formed from them, according to the twelfth propoſition.

Cor. It follows from this propoſition that the arts of logic, and rational grammar, depend entirely on the doctrine of aſſociation. For logic, conſidered as the art of thinking or reaſoning, treats only of ſuch ideas as are annexed to words; and, as the art of diſcourſing, it teaches the proper uſe of words in a general way, as grammar does in a more minute and particular one.

PROP. LXXX.

To deſcribe the Manner in which Ideas are aſſociated with Words, beginning from Childhood.

This may be done by applying the doctrine of aſſociation, as laid down in the firſt chapter, to words conſidered in the four lights mentioned under the laſt propoſition.

Firſt, then, The aſſociation of the names of viſible objects, with the impreſſions which theſe objects make upon the eye, ſeems to take place more early than any other, and to be effected in the following manner: the name of the viſible object, the nurſe, for inſtance, is pronounced and repeated by the attendants to the child, more frequently when his eye is fixed upon the nurſe, than when upon other objects, and much more ſo than when upon any particular one. The word *nurſe* is alſo ſounded in an emphatical manner, when the child's eye is directed to the nurſe with earneſtneſs and deſire. The aſſociation therefore of the ſound *nurſe*, with the picture of the nurſe upon the *retina*, will be far ſtronger than that with any other viſible impreſſion, and thus overpower all the other accidental aſſociations, which will alſo themſelves contribute to the ſame end by oppoſing one another. And when the child has gained ſo much voluntary power over his motions, as to direct his head and eyes towards the nurſe upon hearing her name, this proceſs will go on with an accelerated velocity. And thus, at laſt, the word will excite the viſible idea readily and certainly.

The ſame aſſociation of the picture of the nurſe in the eye with the ſound *nurſe* will, by degrees, overpower all the accidental aſſociations of this picture with other words, and be ſo firmly cemented at laſt, that the picture will excite the audible idea of the word. But this is not to our preſent purpoſe. I mention it here as taking place at the ſame time with the foregoing proceſs, and contributing to illuſtrate and confirm it. Both together afford a complete inſtance for the tenth and eleventh propoſitions, *i. e.* they ſhew, that when the impreſſions *A* and *B* are ſufficiently aſſociated, *A* impreſſed alone will excite *b*, *B* impreſſed alone will excite *a*.

Secondly, This aſſociation of words with viſible appearances, being made under any particular circumſtances, muſt affect the viſible ideas with a like particularity. Thus the nurſe's dreſs, and the ſituation of the fire in the child's nurſery, make part of the child's ideas of his nurſe and fire. But then as the nurſe often changes her dreſs, and the child often ſees a fire in a different place, and ſurrounded by different viſible objects, theſe oppoſite aſſociations muſt be leſs ſtrong, than the part which is common to them all; and conſequently we may ſuppoſe, that while his idea of that part which is common, and which we may call eſſential, continues the ſame, that of the particularities, circumſtances, and adjuncts, varies. For he cannot have any idea, but with ſome particularities in the non-eſſentials.

Thirdly, When the viſible objects impreſs other vivid ſenſations beſides thoſe of ſight, ſuch as grateful or ungrateful taſtes, ſmells, warmth or coldneſs, with ſufficient frequency, it follows from the foregoing theory, that theſe ſenſations muſt leave traces, or ideas, which will be aſſociated with the names of the objects, ſo as to depend upon them. Thus an idea, or naſcent perception, of the ſweetneſs of the nurſe's milk will riſe up in that part of the child's brain which correſponds to the nerves of taſte, upon his hearing her name. And hence the whole idea belonging to the word *nurſe* now begins to be complex, as conſiſting of a viſible idea, and an idea of taſte. And theſe two ideas will be aſſociated together, not only becauſe the word raiſes them both, but alſo becauſe the original ſenſations are. The ſtrongeſt may therefore aſſiſt in raiſing the weakeſt. Now, in common caſes, the viſible idea is ſtrongeſt, or occurs moſt readily at leaſt; but, in the preſent inſtance, it ſeems to be otherwiſe. We might proceed in like manner to ſhew the generation of ideas more and more complex, and the various ways by which their parts are cemented together, and all made to depend on the reſpective names of the viſible objects. But what has been ſaid may ſuffice to ſhew what ideas the names of viſible objects, proper and appellative, raiſe in us.

Fourthly, We muſt, however, obſerve, in reſpect of appellatives, that ſometimes the idea is the common compound reſult of all the ſenſible impreſſions received from the ſeveral objects compriſed under the general appellation; ſometimes the particular idea of ſome one of theſe, in great meaſure at leaſt, viz. when the impreſſions ariſing from ſome one are more novel, frequent, and vivid, than thoſe from the reſt.

Fifthly, The words denoting ſenſible qualities, whether ſubſtantive or adjective, ſuch as *whiteneſs*, *white*, &c. get their ideas in a manner which will be eaſily underſtood from what has been already delivered. Thus the word *white*, being aſſociated with the viſible appearances of milk, linen, paper, gets a ſtable power of exciting the idea of what is common to all, and a variable one in reſpect of the particularities, circumſtances, and adjuncts. And ſo of other ſenſible qualities.

Sixthly, The names of viſible actions, as walking, ſtriking, &c. raiſe the proper viſible ideas by a like proceſs. Other ideas may likewiſe adhere in certain caſes, as in thoſe of taſting, feeling, ſpeaking, &c. Senſible perceptions, in which no viſible action is concerned, as hearing, may alſo leave ideas dependent on words. However, ſome viſible ideas generally intermix themſelves here. Theſe actions and perceptions are generally denoted by verbs, though ſometimes by ſubſtantives.

And we may now ſee in what manner ideas are aſſociated with nouns, proper and appellative, ſubſtantive and adjective, and with verbs, ſuppoſing that they denote ſenſible things only. Pronouns and particles remain to be conſidered. Now, in order to know their ideas and uſes, we muſt obſerve,

Seventhly, That as children may learn to read words not only in an elementary way, viz. by learning the letters and ſyllables of which they are compoſed, but alſo in a ſummary one, viz. by aſſociating the ſound of entire words, with their pictures, in the eye; and muſt, in ſome caſes, be taught in the laſt way, *i. e.* whereſoever the ſound of the word deviates from that of its elements; ſo both children and adults learn the ideas belonging to whole ſentences many times in a ſummary way, and not by adding together the ideas of the ſeveral words in the ſentence. And wherever words occur, which, ſeparately taken, have no proper ideas, their uſe can be learnt in no other way but this. Now pronouns and particles, and many other words, are of this kind. They anſwer, in ſome meaſure, to *x*, *y*, and *z*, or the unknown quantities in algebra, being determinable and decypherable, as one may ſay, only by means of the known words with which they are joined.

Thus *I walk* is aſſociated at different times with the ſame viſible impreſſion as *nurſe walks*, *brother walks*, &c. and therefore can ſuggeſt nothing permanently for a long time but the action of walking. However the pronoun *I*, in this and innumerable other ſhort ſentences, being always aſſociated with the perſon ſpeaking, as *thou* is with the perſon ſpoken to, and *he* with the perſon ſpoken of, the frequent recurrency of this teaches the child the uſe of the pronouns, *i. e.* teaches him what difference he is to expect in his ſenſible impreſſions according as this or that pronoun is uſed; the infinite number of inſtances, as one may ſay, making up for the infinitely ſmall quantity of information, which each, ſingly taken, conveys.

In like manner, different particles, *i. e.* adverbs, conjunctions, and prepoſitions, being uſed in ſentences, where the ſubſtantives, adjectives, and verbs, are the ſame, and the ſame particles, where theſe are different, in an endleſs recurrency, teach children the uſe of the particles in a groſs general way. For it may be obſerved, that children are much at a loſs for the true uſe of the pronouns and particles for ſome years, and that they often repeat the proper name of the perſon inſtead of the pronoun; which confirms the foregoing reaſoning. Some of the inferior parts or particles of ſpeech make ſcarce any alteration in the ſenſe of the ſentence, and therefore are called expletives. The ſeveral terminations of the *Greek* and *Latin* nouns and verbs are of the nature of pronouns and particles.

Eighthly, The attempts which children make to expreſs their own wants, perceptions, pains, &c. in words, and the corrections and ſuggeſtions of the attendants, are of the greateſt uſe in all the ſteps that we have hitherto conſidered, and eſpecially in the laſt, regarding the pronouns and particles.

Ninthly, Learning to read helps children much in the ſame reſpects; eſpecially as it teaches them to ſeparate ſentences into the ſeveral words which compound them; which thoſe who cannot read are ſcarce able to do, even when arrived at adult age.

Thus we may ſee, how children and others are enabled to underſtand a continued diſcourſe relating to ſenſible impreſſions only, and how the words in paſſing over the ear muſt raiſe up trains of viſible and other ideas by the power of aſſociation. Our next inquiry muſt be concerning the words that denote either intellectual things, or collections of other words.

Tenthly, The words, that relate to the ſeveral paſſions of love, hatred, hope, fear, anger, &c. being applied to the child at the times when he is under the influence of theſe paſſions, get the power of raiſing the miniatures or ideas of theſe paſſions, and alſo of the uſual aſſociated circumſtances. The application of the ſame words to others helps alſo to annex the ideas of the aſſociated circumſtances to them, and even of the paſſions themſelves, both from the infectiouſneſs of our natures, and from the power of aſſociated circumſtances to raiſe the paſſions. However, it is to be noted, that the words denoting the paſſions do not, for the moſt part, raiſe up in us any degree of the paſſions themſelves, but only the ideas of the aſſociated circumſtances. We are ſuppoſed to underſtand the continued diſcourſes into which theſe words enter ſufficiently, when we form true notions of the actions, particularly the viſible ones attending them.

Eleventhly, The names of intellectual and moral qualities and operations, ſuch as fancy, memory, wit, dulneſs, virtue, vice, conſcience, approbation, diſapprobation, &c. ſtand for a deſcription of theſe qualities and operations; and therefore, if dwelt upon, excite ſuch ideas as theſe deſcriptions in all their particular circumſtances do. But the common ſentences, which theſe words enter, paſs over the mind too quick, for the moſt part, to allow of ſuch a delay. They are acknowledged as familiar and true, and ſuggeſt certain aſſociated viſible ideas, and naſcent internal feelings, taken from the deſcriptions of theſe names, or from the words, which are uſually joined with them in diſcourſes or writings.

Twelfthly, There are many terms of art in all the branches of learning, which are defined by other words, and which therefore are only compendious ſubſtitutes for them. The ſame holds in common life in numberleſs inſtances. Thus riches, honours, pleaſures, are put for the ſeveral kinds of each. Such words ſometimes ſuggeſt the words of their definitions, ſometimes the ideas of theſe words, ſometimes a particular ſpecies comprehended under the general term, &c. But, whatever they ſuggeſt, it may be eaſily ſeen, that they derive the power of doing this from aſſociation.

Thirteenthly, There are many words uſed in abſtract ſciences, which can ſcarce be defined or deſcribed by any other words; and yet, by their grammatical form, ſeem to be excluded from the claſs of particles. Such are identity, exiſtence, &c. The uſe of theſe muſt therefore be learnt as that of the particles is. And indeed children learn their firſt imperfect notions of all the words conſidered in this and the three laſt paragraphs chiefly in this way; and come to preciſe and explicit ones only by means of books, as they advance to adult age, or by endeavouring to uſe them properly in their own deliberate compoſitions.

This is by no means a full or ſatisfactory account of the ideas which adhere to words by aſſociation. For the author perceives himſelf to be ſtill a mere novice in theſe ſpeculations; and it is difficult to explain words to the bottom by words; perhaps impoſſible. The reader will receive ſome addition of light and evidence in the courſe of this ſection; alſo in the next, in which I ſhall treat of propoſitions and aſſent. For our aſſent to propoſitions, and the influence which they have over our affections and actions, make part of the ideas that adhere to words by aſſociation; which part, however, could not properly be conſidered in this ſection.

Cor. 1. It follows from this propoſition, that words may be diſtinguiſhed into the four claſſes mentioned under the twelfth propoſition.

1. Such as have ideas only.
2. Such as have both ideas and definitions.
3. Such as have definitions only.
4. Such as have neither ideas nor definitions.

Under definition I here include deſcription, or any other way of explaining a word by other words, excepting that by a mere ſynonymous term; and I exclude from the number of ideas the viſible idea of the character of a word, and the audible one of its ſound; it being evident, that every word heard may thus excite a viſible idea, and every word ſeen an audible one. I exclude alſo all ideas that are either extremely faint, or extremely variable.

It is difficult to fix preciſe limits to theſe four claſſes, ſo as to determine accurately where each ends, and the next begins; and, if we conſider theſe things in the moſt general way, there is perhaps no word which has not both an idea and a definition, *i. e.* which is not attended by ſome one or more internal feelings occaſionally, and which may not be explained, in ſome imperfect manner at leaſt, by other words. I will give ſome inſtances of words which have the faireſt right to each claſs.

The names of ſimple ſenſible qualities are of the firſt claſs. Thus *white*, *ſweet*, &c. excite ideas; but cannot be defined. It is to be obſerved here, that this claſs of words ſtands only for the ſtable part of the ideas reſpectively, not for the ſeveral variable particularities, circumſtances, and adjuncts, which intermix themſelves here.

The names of natural bodies, animal, vegetable, mineral, are of the ſecond claſs; for they excite aggregates of ſenſible ideas, and at the ſame time may be defined (as appears from the writings of natural hiſtorians) by an enumeration of their properties and characteriſtics. Thus likewiſe geometrical figures have both ideas and definitions. The definitions in both caſes are ſo contrived as to leave out all the variable particularities of the ideas, and to be alſo more full and preciſe, than the ideas generally are in the parts that are of a permanent nature.

Algebraic quantities, ſuch as roots, powers, ſurds, &c. belong to the third claſs, and have definitions only. The ſame may be ſaid of ſcientifical terms of art, and of moſt abſtract general terms, moral, metaphyſical, vulgar: however, mental emotions are apt to attend ſome of theſe even in paſſing ſlightly over the ear; and theſe emotions may be conſidered as ideas belonging to the terms reſpectively. Thus the very words, *gratitude*, *mercy*, *cruelty*, *treachery*, &c. ſeparately taken, affect the mind; and yet, ſince all reaſoning upon them is to be founded on their definitions, as will be ſeen hereafter, it ſeems beſt to refer them to this third claſs.

Laſtly, the particles *the*, *of*, *to*, *for*, *but*, &c. have neither definitions nor ideas.

Cor. 2. This matter may be illuſtrated by comparing language to geometry and algebra, the two general methods of expounding quantity, and inveſtigating all its varieties from previous *data*.

Words of the firſt claſs anſwer to propoſitions purely geometrical, *i. e.* to ſuch as are too ſimple to admit of algebra; of which kind we may reckon that concerning the equality of the angles at the baſis of an Iſoſceles triangle.

Words of the ſecond claſs anſwer to that part of geometry, which may be demonſtrated either ſynthetically or analytically; either ſo that the learner's imagination ſhall go along with every ſtep of the proceſs painting out each line, angle, &c. according to the method of demonſtration uſed by the ancient mathematicians; or ſo that he ſhall operate entirely by algebraic quantities and methods, and only repreſent the concluſion to his imagination, when he is arrived at it, by examining then what geometrical quantities the ultimately reſulting algebraical ones denote. The firſt method is in both caſes the moſt ſatisfactory and affecting, the laſt the moſt expeditious, and not leſs certain, where due care is taken. A blind mathematician muſt uſe words in the laſt of theſe methods, when he reaſons upon colours.

Words of the third claſs anſwer to ſuch problems concerning quadratures, and rectifications of curves, chances, equations of the higher orders, &c. as are too perplexed to be treated geometrically.

Laſtly, Words of the fourth claſs anſwer to the algebraic ſigns for addition, ſubtraction, &c. to indexes, coefficients, &c. Theſe are not algebraic quantities themſelves; but they alter the import of the letters that are; juſt as particles vary the ſenſe of the principal words of a ſentence, and yet ſignify nothing of themſelves.

Geometrical figures may be conſidered as repreſenting all the modes of extenſion in the ſame manner, as viſible ideas do viſible objects; and conſequently the names of geometrical figures anſwer to the names of theſe ideas. Now as all kinds of problems relating to quantity might be expounded by modes of extenſion, and ſolved thereby, were our faculties ſufficiently exalted, ſo it appears poſſible to repreſent moſt kinds of ideas by viſible ones, and to purſue them in this way through all their varieties and combinations. But as it ſeems beſt in the firſt caſe to confine geometry to problems, where extenſion, and motion, which implies extenſion, are concerned, uſing algebraic methods for inveſtigating all other kinds of quantity, ſo it ſeems beſt alſo to uſe viſible ideas only for viſible objects and qualities, of which they are the natural repreſentatives, and to denote all other qualities by words conſidered as arbitrary ſigns. And yet the repreſentation of other quantities by geometrical ones, and of other ideas by viſible ones, is apt to make a more vivid impreſſion upon the fancy, and a more laſting one upon the memory. In ſimiles, fables, parables, allegories, viſible ideas are uſed for this reaſon to denote general and intellectual ones.

Since words may be compared to the letters uſed in algebra, language itſelf may be termed one ſpecies of algebra; and, converſely, algebra is nothing more than the language which is peculiarly fitted to explain quantity of all kinds. As the letters, which in algebra ſtand immediately for quantities, anſwer to the words which are immediate repreſentatives of ideas, and the algebraic ſigns for addition, &c. to the particles; ſo the ſingle letters, which are ſometimes uſed by algebraiſts to denote ſums or differences, powers or roots univerſal of other letters, for brevity and convenience, anſwer to ſuch words as have long definitions, to terms of art, &c. which are introduced into the ſciences for the ſake of compendiouſneſs. Now, if every thing relating to language had ſomething analogous to it in algebra, one might hope to explain the difficulties and perplexities attending the theory of language by the correſponding particulars in algebra, where every thing is clear, and acknowledged by all that have made it their ſtudy. However, we have here no independent point whereon to ſtand, ſince, if a perſon be diſpoſed to call the rules of algebra in queſtion, we have no way of demonſtrating them to him, but by uſing words, the things to be explained by algebra, for that purpoſe. If we ſuppoſe indeed the ſceptical perſon to allow only that ſimple language, which is neceſſary for demonſtrating the rules of algebra, the thing would be done; and, as I obſerved juſt now, it ſeems impoſſible to become acquainted with this, and at the ſame time to diſallow it.

Cor. 3. It will eaſily appear from the obſervations here made upon words, and the aſſociations which adhere to them, that the languages of different ages and nations muſt bear a great general reſemblance to each other, and yet have conſiderable particular differences; whence any one may be tranſlated into any other, ſo as to convey the ſame ideas in general, and yet not with perfect preciſion and exactneſs. They muſt reſemble one another, becauſe the phænomena of nature, which they are all intended to expreſs, and the uſes and exigencies of human life, to which they miniſter, have a general reſemblance. But then, as the bodily make and genius of each people, the air, ſoil, and climate, commerce, arts, ſciences, religion, &c. make conſiderable differences in different ages and nations, it is natural to expect,

pect, that the languages ſhould have proportionable differences in reſpect of each other.

Where languages have rules of etymology and ſyntax, that differ greatly, which is the caſe of the *Hebrew* compared with *Greek* or *Latin*, this will become a new ſource of difformity. For the rules of etymology and ſyntax determine the application and purport of words in many caſes. Agreeably to which we ſee, that children, while yet unacquainted with that propriety of words and phraſes, which cuſtom eſtabliſhes, often make new words and conſtructions, which, though improper according to common uſage, are yet very analogous to the tenor of the language, in which they ſpeak.

The modern languages of this weſtern part of the world anſwer better to the *Latin*, than according to their original *Gothic* plans, on this account; inaſmuch as not only great numbers of words are adopted by all of them from the *Latin*, but alſo becauſe the reading *Latin* authors, and learning the *Latin* grammar, have diſpoſed learned men and writers to mould their own languages in ſome meaſure after the *Latin*. And, converſely, each nation moulds the *Latin* after the idiom of its own language, the effect being reciprocal in all ſuch caſes.

In learning a new language the words of it are at firſt ſubſtitutes for thoſe of our native language, *i. e.* they are aſſociated, by means of theſe, with the proper objects and ideas. When this aſſociation is ſufficiently ſtrong, the middle bond is dropped, and the words of the new language become ſubſtitutes for, and ſuggeſt directly and immediately objects and ideas; alſo cluſters of other words in the ſame language.

In learning a new language it is much eaſier to tranſlate from it into the native one, than back again; juſt as young children are much better able to underſtand the expreſſions of others, than to expreſs their own conceptions. And the reaſon is the ſame in both caſes. Young children learn at firſt to go from the words of others; and thoſe who learn a new language, from the words of that language, to the things ſignified. And the reverſe of this, viz. to go from the things ſignified to the words, muſt be difficult for a time, from what is delivered concerning ſucceſſive aſſociations under the tenth and eleventh propoſitions. It is to be added here, that the nature and connections of the things ſignified often determine the import of ſentences, though their grammatical analyſis is not underſtood; and that we ſuppoſe the perſon who attempts to tranſlate from a new language is ſufficiently expert in the inverſe problem of paſſing from the things ſignified to the correſponding words of his own language. The power of aſſociation is every where conſpicuous in theſe remarks.

COR. 4. It follows alſo from the reaſoning of this propoſition, that perſons who ſpeak the ſame language cannot always mean the ſame things by the ſame words; but muſt miſtake each other's meaning. This confuſion and uncertainty ariſes from the different aſſociations transferred upon the ſame words by the difference in the accidents and events of our lives. It is, however, much more common in diſcourſes concerning abſtract matters, where the terms ſtand for collections of other terms, ſometimes at the pleaſure of the ſpeaker or writer, than in the common and neceſſary affairs of life. For here frequent uſe, and the conſtancy of the phænomena of nature, intended to be expreſſed by words, have rendered their ſenſe determinate and certain. However, it ſeems poſſible, and even not very difficult, for two truly candid and intelligent perſons to underſtand each other upon any ſubject.

That we may enter more particularly into the cauſes of this confuſion, and conſequently be the better enabled to prevent it, let us conſider words according to the four claſſes above-mentioned.

Now miſtakes will happen in the words of the firſt claſs, viz. ſuch as have ideas only, where the perſons have aſſociated theſe words with different impreſſions. And the method to rectify any miſtake of this kind is for each perſon to ſhew with what actual impreſſions he has aſſociated the word in queſtion. But miſtakes here are not common.

In words of the ſecond claſs, viz. ſuch as have both ideas and definitions, it often happens, that one perſon's knowledge is much more full than another's, and conſequently his idea and definition much more extenſive. This muſt cauſe a miſapprehenſion on one ſide, which yet may be eaſily rectified by recurring to the definition. It happens alſo ſometimes in words of this claſs, that a man's ideas, *i. e.* the miniatures excited in his nervous ſyſtem by the word, are not always ſuitable to his definition, *i. e.* are not the ſame with thoſe which the words of the definition would excite. If then this perſon ſhould pretend, or even deſign, to reaſon from his definition, and yet reaſon from his idea, a miſapprehenſion will ariſe in the hearer, who ſuppoſes him to reaſon from his definition merely.

In words of the third claſs, which have definitions only, and no immediate ideas, miſtakes generally ariſe through want of fixed definitions mutually acknowledged and kept to. However, as imperfect fluctuating ideas, that have little relation to the definitions, are often apt to adhere to the words of this claſs, miſtakes muſt ariſe from this cauſe alſo.

As to the words of the fourth claſs, or thoſe which have neither ideas nor definitions, it is eaſy to aſcertain their uſe by inſerting them in ſentences, whoſe import is known and acknowledged; this being the method in which children learn to decypher them: ſo that miſtakes could not ariſe in the words of this claſs, did we uſe moderate care and candour. And indeed ſince children learn the uſes of words moſt evidently without having any *data*, any fixed point at all, it is to be hoped, that philoſophers, and candid perſons, may learn at laſt to underſtand one another with facility and certainty; and get to the very bottom of the connection between words and ideas.

It ſeems practicable to make a dictionary of any language, in which the words of that language ſhall all be explained with preciſion by words of the ſame language, to perſons who have no more than a groſs knowledge of that language. Now this alſo ſhews, that with care and candour we might come to underſtand one another perfectly. Thus ſenſible qualities might be fixed by the bodies, in which they are moſt eminent and diſtinct; the names of a ſufficient number of theſe bodies being very well known. After this theſe very bodies, and all others, might be defined by their ſenſible properties; and theſe two proceſſes would help each other indefinitely. Actions might be deſcribed from animals already defined, alſo from the modes of extenſion, abſtract terms defined, and the peculiar uſe of particles aſcertained. And ſuch a dictionary would, in ſome meaſure, be a real as well as a nominal one, and extend to things themſelves. The writer of every new and difficult work may execute that part of ſuch a dictionary which belongs to his ſubject; at leaſt in the inſtances where he apprehends the reader is likely to want it.

Cor. 5. When words have acquired any conſiderable power of exciting pleaſant or painful vibrations in the nervous ſyſtem, by being often aſſociated with ſuch things as do this, they may transfer a part of theſe pleaſures and pains upon indifferent things, by being at other times often aſſociated with ſuch. This is one of the principal ſources of the ſeveral factitious pleaſures and pains of human life. Thus, to give an inſtance from childhood, the words *ſweet*, *good*, *pretty*, *fine*, &c. on the one hand, and the words, *bad*, *ugly*, *frightful*, &c. on the other, being applied by the nurſe and attendants in the young child's hearing almoſt promiſcuouſly, and without thoſe reſtrictions that are obſerved in correct ſpeaking, the one to all the pleaſures, the other to all the pains of the ſeveral ſenſes, muſt by aſſociation raiſe up general pleaſant and painful vibrations, in which no one part can be diſtinguiſhed above the reſt; and, when applied by farther aſſociations to objects of a neutral kind, they muſt transfer a general pleaſure or pain upon them.

All the words aſſociated with pleaſures muſt alſo affect each other by this promiſcuous application. And the ſame holds in reſpect of the words aſſociated with pains. However, ſince both the original and the transferred pleaſures and pains heaped upon different words are different, and in ſome caſes widely ſo, every remarkable word will have a peculiar internal feeling, or ſentiment, belonging to it; and there will be the ſame relations of affinity, diſparity, and oppoſition, between theſe internal ſentiments, *i. e.* ideas, belonging to words, as between the ſeveral *genera* and *ſpecies* of natural bodies, between taſtes, ſmells, colours, &c. Many of theſe ideas, though affording conſiderable pleaſure at firſt, muſt ſink into the limits of indifference; and ſome of thoſe which afforded pain at firſt, into the limits of pleaſure. What is here ſaid of words, belongs to cluſters of them, as well as to ſeparate words. And the ideas of all may ſtill retain their peculiarities, by which they are diſtinguiſhed from each other, after they have fallen below the limits of pleaſure into indifference, juſt as obſcure colours, or faint taſtes, do.

It is obſervable, that the mere tranſit of words expreſſing ſtrong ideas over the ears of children affects them; and the ſame thing is true of adults, in a leſs degree. However the laſt have learnt from experience and habit to regard them chiefly, as they afford a rational expectation of pleaſure and pain. This cannot be diſcuſſed fully, till we come to conſider the nature of aſſent; but it may give ſome light and evidence to the reaſoning of this corollary, juſt to have mentioned the manner, in which we are at firſt affected by words.

Cor. 6. Since words thus collect ideas from various quarters, unite them together and transfer them both upon other words, and upon foreign objects, it is evident, that the uſe of words adds much to the number and complexneſs of our ideas, and is the principal means by which we make intellectual and moral improvements. This is verified abundantly by the obſervations that are made upon perſons born deaf, and continuing ſo. It is probable, however, that theſe perſons make uſe of ſome ſymbols to aſſiſt the memory, and fix the fancy: and they muſt have a great variety of pleaſures and pains transferred upon viſible objects from their aſſociations with one another, and with ſenſible pleaſures of all the kinds; but they are very deficient in this, upon the whole, through the want of the aſſociations of viſible objects, and ſtates of mind, &c. with words. Learning to read muſt add greatly to their mental improvement; yet ſtill their intellectual capacities cannot but remain very narrow.

Perſons blind from birth muſt proceed in a manner different from that deſcribed in this propoſition, in the firſt ideas, which they affix to words. As the viſible ones are wanting, the others, particularly the tangible and audible ones, muſt compoſe the aggregates which are annexed to words. However, as they are capable of learning and retaining as great a variety of words as others, or perhaps a greater, *cæteris paribus*, and can aſſociate with them pleaſures and pains from the four remaining ſenſes, alſo uſe them as algebraiſts do the letters that repreſent quantities, they fall little or nothing ſhort of others in intellectual accompliſhments, and may arrive even at a greater degree of ſpirituality, and abſtraction in their complex ideas.

Cor. 7. It follows from this propoſition, that, when children or others firſt learn to read, the view of the words excites ideas only by the mediation of their ſounds, with which alone their ideas have hitherto been aſſociated. And thus it is that children and illiterate perſons underſtand what they read beſt by reading aloud. By degrees, the intermediate link being left out, the written or printed characters ſuggeſt the ideas directly and inſtantaneouſly; ſo that learned men underſtand more readily by paſſing over the words with the eye only, ſince this method, by being more expeditious, brings the ideas cloſer together. However, all men, both learned and unlearned, are peculiarly affected by words pronounced in a manner ſuitable to their ſenſe and deſign; which is ſtill an aſſociated influence.

Cor. 8. As perſons, before they learn to read, muſt have very imperfect notions of the diſtinction of words, and can only underſtand language in a groſs general way, taking whole cluſters of words for one undivided ſound, ſo much leſs can they be ſuppoſed to have any conceptions concerning the nature or uſe of letters. Now all mankind muſt have been in this ſtate before the invention of letters. Nay, they muſt have been farther removed from all conceptions of letters, than the moſt unlearned perſons amongſt us, ſince theſe have at leaſt heard of letters, and know that words may be written and read by means of them. And this makes it difficult to trace out by what ſteps alphabetical writing was invented; or is even ſome preſumption, that it is not a human invention. To which it is to be added, that the analyſing complex articulate ſounds into their ſimple component parts appears to be a problem of too difficult and perplexed a nature a nature for the rude early ages, occupied in getting neceſſaries, and defending themſelves from external injuries, and not aware of the great uſe of it, even though they had known the ſolution to be poſſible and practicable. However, I ſhall mention ſome preſumptions of a contrary nature under the next propoſition.

PROP. LXXXI.

To explain the Nature of Characters intended to repreſent Objects and Ideas immediately, and without the Intervention of Words.

SINCE characters made by the hand are capable of the greateſt varieties, they might be fitted by proper aſſociations to ſuggeſt objects and ideas immediately, in the ſame manner as articulate ſounds do. And there are ſome inſtances of it in common uſe, which may ſerve to verify this, and to lead us into the nature of characters ſtanding immediately for objects and ideas. Thus the numeral figures, and the letters in algebra, repreſent objects, ideas, words, and cluſters of words, directly and immediately; the pronunciation of them being of no uſe, or neceſſity, in the operations to be performed by them. Thus alſo muſical characters repreſent ſounds and combinations of ſounds, without the intervention of words, and are a much more compendious and ready repreſentation, than any words can be.

Characters ſeem to have an advantage over articulate ſounds in the repreſentation of viſible objects, inaſmuch as they might by their reſemblance, even though only a groſs one, become rather natural, than mere arbitrary repreſentatives.

They had alſo an advantage as repreſentatives in general, before the invention of alphabetical writing, ſince perſons could by this means convey their thoughts to each other at a diſtance.

If we ſuppoſe characters to be improved to all that variety and multiplicity, which is neceſſary for repreſenting objects, ideas, and cluſters of characters, in the ſame manner as words repreſent objects, ideas, and cluſters of words, ſtill they might be reſolved into ſimple component parts; and rendered pronunciable by affixing ſome ſimple or ſhort ſound to each of theſe ſimple component parts; juſt as articulate ſounds are painted by being firſt reſolved into their ſimple component parts, and then having each of theſe repreſented by a ſimple mark or character.

If we ſuppoſe the moſt common viſible objects to be denoted both by ſhort articulate ſounds, and by ſhort characters bearing ſome real, or fancied, imperfect reſemblance to them, it is evident, that the ſound and mark, by being both aſſociated with the viſible object, would alſo be aſſociated with one another; and conſequently that the ſound would be the name of the mark, and the mark the picture of the ſound. And this laſt circumſtance ſeems to lead to the denoting all ſounds by marks, and therefore perhaps to alphabetical writing.

At the ſame time it muſt be obſerved, that the marks would bear different relations of ſimilarity and diſſimilarity to one another from thoſe which the correſponding ſounds did.

This would happen according to whatever law the marks were made, but eſpecially if they were reſemblances of viſible objects. And this, as it ſeems, would occaſion ſome difficulty and perplexity in repreſenting ſounds by marks, or marks by ſounds.

PROP.

PROP. LXXXII.

To explain the Nature of figurative Words and Phraſes, and of Analogy, from the foregoing Theory.

A FIGURE is a word, which, firſt repreſenting the object or idea *A*, is afterwards made to repreſent *B*, on account of the relation, which theſe bear to each other.

The principal relation, which gives riſe to figures, is that of likeneſs; and this may be either a likeneſs in ſhape, and viſible appearance, or one in application, uſe, &c. Now it is very evident from the nature of aſſociation, that objects which are like to a given one in viſible appearance, will draw to themſelves the word by which this is expreſſed. And indeed this is the foundation upon which appellatives are made to ſtand for ſo great a number of particulars. Let the word *man* be applied to the particular perſons *A*, *B*, *C*, &c. till it be ſufficiently aſſociated with them, and it will follow, that the appearance of the new particular perſon *D* will ſuggeſt the word, and be denoted by it. But here there is no figure, becauſe the word *man* is aſſociated with different particular perſons from the firſt, and that equally or nearly ſo.

In like manner, the correſponding parts of different animals, *i. e.* the eyes, mouth, breaſt, belly, legs, lungs, heart, &c. have the ſame names applied in a literal ſenſe, partly from the likeneſs of ſhape, partly from that of uſe and application. And it is evident, that if we ſuppoſe a people ſo rude in language and knowledge, as to have names only for the parts of the human body, and not to have attended to the parts of the brute creatures, aſſociation would lead them to apply the ſame names to the parts of the brute creatures, as ſoon as they became acquainted with them. Now here this application would at firſt have the nature of a figure; but when by degrees any of theſe words, the eye for inſtance, became equally applied from the firſt to the eyes of men and brutes, it would ceaſe to be a figure, and become an appellative name, as juſt now remarked.

But when the original application of the word is obvious, and remains diſtinct from the ſecondary one, as when we ſay the mouth or ear of a veſſel, or the foot of a chair or table, the expreſſion is figurative.

Hence it is plain, that the various reſemblances which nature and art afford are the principal ſources of figures. However, many figures are alſo derived from other relations, ſuch as thoſe of cauſe, effect, oppoſition, derivation, generality, particularity; and language itſelf, by its reſemblances, oppoſitions, &c. becomes a new ſource of figures, diſtinct from the relations of things.

Moſt metaphors, *i. e.* figures taken from likeneſs, imply a likeneſs in more particulars than one, elſe they would not be ſufficiently definite, nor affect the imagination in a due manner. If the likeneſs extend to many particulars, the figure becomes implicitly a ſimile, fable, parable, or allegory.

Many, or moſt common figures, paſs ſo far into literal expreſſions by uſe, *i. e.* aſſociation, that we do not attend at all to their figurative nature. And thus by degrees figurative ſenſes become a foundation for ſucceſſive figures, in the ſame manner, as originally literal ſenſes.

It is evident, that if a language be narrow, and much confined to ſenſible things, it will have great occaſion for figures: theſe will naturally occur in the common intercourſes of life, and will in their turn, as they become literal expreſſions in the ſecondary ſenſes, much augment and improve the language, and aſſiſt the invention. All this is manifeſt from the growth of modern languages, in thoſe parts where they were heretofore particularly defective.

We come now to the conſideration of analogy. Now things are ſaid to be analogous to one another, in the ſtrict mathematical ſenſe of the word *analogy*, when the correſponding parts are all in the ſame ratio to each other. Thus if the ſeveral parts of the body in different perſons be ſuppoſed exactly proportional to the whole bodies, they might be ſaid to be analogous in the original mathematical ſenſe of that word. But as this reſtrained ſenſe is not applicable to things, as they really exiſt, another of a more enlarged and practical nature has been adopted, which may be thus defined. Analogy is that reſemblance, and in ſome caſes ſameneſs, of the parts, properties, functions, uſes, &c. any or all, of *A* to *B*, whereby our knowledge concerning *A*, and the language expreſſing this knowledge, may be applied, in the whole, or in part, to *B*, without any ſenſible, or, at leaſt, any important practical error. Now analogies, in this ſenſe of the word, ſome more exact and extenſive, ſome leſs ſo, preſent themſelves to us every where in natural and artificial things; and thus whole groups of figurative phraſes, which ſeem at firſt only to anſwer the purpoſes of convenience in affording names for new objects, and of pleaſing the fancy in the way to be hereafter mentioned, paſs into analogical reaſoning, and become a guide in the ſearch after truth, and an evidence for it in ſome degree. I will here ſet down ſome inſtances of analogies of various degrees and kinds.

The bodies of men, women, and children, are highly analogous to each other. This holds equally in reſpect of every other ſpecies of animals; alſo of the ſeveral correſponding parts of animals of the ſame ſpecies, as their fleſh, blood, bones, fat, &c. and their properties. Here the words applied to the ſeveral analogous things are uſed in a ſenſe equally literal in reſpect of all. And the analogy is in moſt caſes ſo cloſe, as rather to be eſteemed a coincidence, or ſameneſs.

In comparing animals of different kinds the analogy grows perpetually leſs and leſs, as we take in a greater compaſs; and conſequently our language more and more harſh, when conſidered as literal, whilſt yet it cannot well be figurative in ſome things, and literal in others; ſo that new words are generally aſſigned to thoſe parts, which do not ſufficiently reſemble the correſponding ones. Thus the fore-legs of men and fowls, as we might call them in a harſh, literal, or a highly figurative way, are termed hands and wings reſpectively. However, in ſome caſes, the ſame word is uſed, and conſidered as a figure; as when the cries of birds and beaſts are termed their language. We may alſo obſerve, that every part in every animal may, from its reſemblance in ſhape and uſe to the correſponding parts in ſeveral other animals have a juſt right to a name, which ſhall be common to it and them.

What has been ſaid of animals of the ſame and different kinds holds equally in reſpect of vegetables. Thoſe of the ſame kind have the ſame names applied to the correſponding parts in a literal ſenſe. Thoſe of different kinds have many names common to all uſed in a literal ſenſe, ſome new ones peculiar to certain kinds, and ſome that may be conſidered as ſo harſh in a literal ſenſe, that we may rather call them figurative terms.

The ſame may be ſaid of the mineral kingdom, conſidered alſo according to its *genera* and *ſpecies.*

Animals are alſo analogous to vegetables in many things, and vegetables to minerals: ſo that there ſeems to be a perpetual thread of analogy continued from the moſt perfect animal to the moſt imperfect mineral, even till we come to elementary bodies themſelves.

Suppoſe the ſeveral particulars of the three kingdoms to be repreſented by the letters of an alphabet ſufficiently large for that purpoſe. Then we are to conceive, that any two contiguous ſpecies, as *A* and *B*, *M* and *N*, are more analogous than *A* and *C*, *M* and *O*, which have one between them. However, ſince *A* and *B*, *M* and *N*, are not perfectly analogous, this deficiency may be ſupplied in ſome things from *C* and *O*, in others from *D* and *P*, &c. ſo that *M* can have no part, property, &c. but what ſhall have ſomething quite analogous to it in ſome ſpecies, near or remote, above it or below it, and even in ſeveral ſpecies. And in caſes where the parts, properties, &c. are not rigorouſly exact in reſemblance, there is, however, an imperfect one, which juſtifies the application of the ſame word to both; if it approach to perfection, the word may be ſaid to be uſed in a literal ſenſe; if it be very imperfect, in a figurative one. Thus when the names of parts, properties, &c. are taken from the animal kingdom, and applied to the vegetable, or *vice verſa*, they are more frequently conſidered as figurative, than when tranſferred from one part of the animal kingdom to another.

In like manner, there ſeems to be a gradation of analogies reſpecting the earth, moon, planets, comets, ſun, and fixed ſtars, compared with one another. Or if we deſcend to the ſeveral parts of individuals, animals, vegetables, or minerals, the ſeveral organs of ſenſation are evidently analogous to each other; alſo the glands, the muſcles, the parts of generation in the different ſexes of the ſame kind, &c. &c. without limits. For the more any one looks into the external natural world, the more analogies, general or particular, perfect or imperfect, will he find every where.

Numbers, geometrical figures, and algebraic quantities, are alſo mutually analogous without limits.

And here there is the exacteſt uniformity, joined with an endleſs variety, ſo that it is always certain and evident how far the analogy holds, and where it becomes a diſparity or oppoſition on one hand, or a coincidence on the other. There is no room for figures here; but the terms muſt be diſparate, oppoſite, or the ſame, in a ſtrictly literal ſenſe reſpectively.

The ſeveral words of each particular language, the languages themſelves, the idioms, figures, &c. abound alſo with numerous analogies of various kinds and degrees.

Analogies are likewiſe introduced into artificial things, houſes, gardens, furniture, dreſs, arts, &c.

The body politic, the body natural, the world natural, the univerſe;——The human mind, the minds of brutes on one hand, and of ſuperior beings on the other, and even the infinite mind himſelf;——the appellations of father, governor, judge, king, architect, &c. referred to God;—the ages of man, the ages of the world, the ſeaſons of the year, the times of the day;—the offices, profeſſions, and trades, of different perſons, ſtateſmen, generals, divines, lawyers, phyſicians, merchants;—the terms night, ſleep, death, chaos, darkneſs, &c. alſo light, life, happineſs, &c. compared with each other reſpectively; life and death, as applied in different ſenſes to animals, vegetables, liquors, &c. —earthquakes, ſtorms, battles, tumults, fermentations of liquors, law-ſuits, games, &c. families, bodies politic leſſer and greater, their laws, natural religion, revealed religion, &c. &c. afford endleſs inſtances of analogies natural and artificial. For the mind being once initiated into the method of diſcovering analogies, and expreſſing them, does by aſſociation perſevere in this method, and even force things into its ſyſtem by concealing diſparities, magnifying reſemblances, and accommodating language thereto. It is eaſy to ſee, that in the inſtances laſt alleged the terms uſed are for the moſt part literal only in one ſenſe, and figurative in all their other applications. They are literal in the ſenſe which was their primary one, and figurative in many or moſt of the reſt. Similes, fables, parables, allegories, &c. are all inſtances of natural analogies improved and ſet off by art. And they have this in common to them all, that the properties, beauties, perfections, deſires, or defects and averſions, which adhere by aſſociation to the ſimile, parable of emblem of any or kind, are inſenſibly, as it were, transferred upon the thing repreſented. Hence the paſſions are moved to good or to evil, ſpeculation is turned into practice, and either ſome important truth felt and realized, or ſome error and vice gilded over and recommended.

PROP. LXXXIII.

To apply the foregoing Account of Words and Characters to the Languages and Method of Writing of the firſt Ages of the World.

Here there is a great difficulty through the want of ſufficient *data*. I will aſſume a few of thoſe that appear to me moſt probable, and juſt ſhew the method of applying the doctrine of aſſociation to them; leaving it to learned men, as they become poſſeſſed of more and more certain *data*, to make farther advances.

I ſuppoſe then, that *Adam* had ſome language, with ſome inſtinctive knowledge concerning the uſe of it, as well as concerning divine and natural things, imparted to him by God at his creation. It ſeems indeed, that God made uſe of the viſible appearances or actions, or perhaps of the ſeveral cries of the brute creatures, as the means whereby he taught *Adam* their names. But whether this was ſo, alſo whether, if it was, any analogous method was taken in reſpect of the names of other objects, or of ideas, and internal feelings, is an inquiry, in which nothing that yet appears can afford ſatisfaction.

I ſuppoſe alſo, that the language, which *Adam* and *Eve* were poſſeſſed of in paradiſe was very narrow, and confined in great meaſure to viſible things; God himſelf condeſcending to appear in a viſible, perhaps in a human ſhape, to them, in his revelations of himſelf. It might alſo be monoſyllabic in great meaſure. They who ſuppoſe *Adam* to be capable of deep ſpeculations, and to have exceeded all his poſterity in the ſubtilty and extent of his intellectual faculties, and conſequently in the number and variety of his words, and the ideas belonging to them, have no foundation for this opinion in ſcripture; nor do they ſeem to conſider, that innocence, and pure unmixed happineſs, may exiſt without any great degrees of knowledge; or that to ſet a value upon knowledge conſidered in itſelf, and excluſively of its tendency to carry us to God, is a moſt pernicious error, derived originally from *Adam*'s having eaten of the tree of knowledge.

After the fall we may ſuppoſe, that *Adam* and *Eve* extended their language to new objects and ideas, and eſpecially to thoſe which were attended with pain; and this they might do ſometimes by inventing new words, ſometimes by giving new ſenſes to old ones. However, their language would ſtill continue narrow, becauſe they had only one another to converſe with, and could not extend their knowledge to any great variety of things; alſo becauſe their foundation was narrow. For the growth and variations of a language ſomewhat reſemble the increaſe of money at intereſt upon intereſt.

If to theſe reaſons we add the long lives of the antediluvian patriarchs, the want of arts and ſciences in the antediluvian world, and the want of leiſure through the great labour and fatigue neceſſary to provide food, clothing, &c. we ſhall have reaſon to conjecture, that the whole antediluvian world would ſpeak the ſame language with *Adam*, and that without any great additions or alterations. After a hundred or two hundred years, aſſociation would fix the language of each perſon, ſo that he could not well make any alterations; but he muſt ſpeak the language of his forefathers till that time, becauſe thoſe to the ſixth or ſeventh generation above him were ſtill living; and conſequently he would continue to ſpeak the ſame language, *i. e.* the *Adamic*, with few variations, to the laſt. The narrowneſs of the languages of barbarous nations may add ſome light and evidence here.

If we ſuppoſe ſome kind of picture-writing to have been imparted to *Adam* by God, or to have been invented by him, or by any of his poſterity, this might receive more alterations and improvements than language, from the ſucceſſive generations of the antediluvians. For the variety of figures in viſible objects would ſuggeſt a ſufficient variety in their characters; the hand could eaſily execute this; and their permanency would both give the antediluvians diſtinct ideas of all the original characters, and all their variations, and alſo fix them in their memory. We may ſuppoſe therefore, that though their words and marks would be ſo aſſociated together (agreeably to what was before obſerved), as that the word would be the name of the correſponding mark, and the mark the picture of the word in many caſes, yet their marks would in ſome inſtances extend farther than their words; and conſequently, that on this account, as well as becauſe the marks would be ſimilar and different, where the words were not, there would be no alphabetical writing in the antediluvian world.

They might, however, hand down a hiſtory of the creation, fall, and principal events, in this picture-writing, attended with a traditional explanation, which might remain uncorrupted and invariable till the deluge. And indeed, if we ſuppoſe picture-writing to be of divine original, it will be moſt probable, that they received a divine direction to do this, and that they would not apply their picture-writing to any other purpoſe for ſome time: juſt as the *Iſraelites* afterwards ſeem to have employed alphabetical writing chiefly for recording the divine diſpenſations and interpoſitions.

After the flood the great change made in the face of things, and in natural bodies, with the appearance perhaps of ſome entirely new ones, would make ſome parts of the antediluvian language ſuperfluous, at the ſame time that it would be greatly defective upon the whole. Hence we may ſuppoſe, that the antediluvian language muſt receive much greater alterations and additions juſt after the flood, than at any time before. But *Noah* and his wife, having their words and ideas more firmly aſſociated together, than *Shem*, *Ham*, and *Japhet*, and their wives, on account of their ſuperior age, would be far leſs able to make the requiſite changes in their language. Something like this muſt alſo take place in reſpect of their picture-writing, if we ſuppoſe there was any ſuch thing in the antediluvian world.

Let us ſuppoſe this, and alſo with Mr. *Whiſton* and Mr. *Shuckford*, that *Noah*, his wife, and their poſtdiluvian poſterity, ſettled early in *China*, ſo as to be cut off from *Shem*, *Ham*, and *Japhet*, and their poſterity. Here then we may ſuppoſe farther, that they would alter and improve their picture-writing, or character, ſo as to ſuit it to the new face of things in the poſtdiluvian world, and to make it grow with the growth of knowledge, more than they would their language, from the greater facility of doing this: for I preſume, that the antediluvian language contained but few of the articulate ſounds which are now known, and that they could not invent more. Thus their character and language would both of them be the immediate repreſentatives of objects and ideas; only the uſe and application of the character would be much more extenſive than that of the language. After ſome time, ſome centuries, or even chiliads, ſuppoſe, both the character and language would begin to be fixed, to have fewer new marks and words added, and fewer alterations made in the old ones in any given interval of time. The words would alſo be ſo firmly aſſociated with the correſponding marks, as to be the names of them, *i. e.* to repreſent them as well as the objects or ideas, to which they were originally affixed. But then there would be many marks, to which there would be no ſuch names, taken from the names of objects and ideas, on account of the poverty of the language here ſuppoſed. They would, however, endeavour to give them ſome names; and hence a diverſity would ariſe in their language. We may conceive alſo, that as they ſeparated farther from one another in multiplying, particular clans would deviate even in the pronunciation of the monoſyllabic words of the original language, as in the ſeveral dialects of other languages; and conſequently deviate ſtill more in the compound names of the marks: but the marks, being permanent things, capable of being handed down accurately to the ſucceſſive generations, and of being conveyed to diſtant countries, would continue intelligible to all. And thus we may conceive, that the poſtdiluvian poſterity of *Noah* might all write the ſame characters, and yet ſpeak different languages; alſo that their character would be very extenſive, and always the immediate repreſentative of objects and ideas, whereas their language would be narrow, and in ſome caſes the immediate repreſentative of the character, and only denote objects and ideas by means of this. And this I take to be the caſe with the people of *China*, and the neighbouring countries of *Japan*, *Tonquim*, *Siam*, &c. But I only preſume to offer conjectures, not having any knowledge of the character or languages of theſe countries.

Since the *Chineſe* marks are very numerous, and their ſimple words very few, whereas our words are very numerous, and our ſimple marks, or the letters of our alphabet, very few; alſo ſince our words are the ſole immediate repreſentatives of objects and ideas, our written and printed marks being merely artificial pictures of words; one might ſuſpect, that the *Chineſe* words are, in correſpondence to this, merely an artificial enunciation of their character. But I think this not ſo probable, as the mixed ſuppoſition mentioned in the laſt paragraph. For it cannot be ſuppoſed, that any nation ſhould be ſo far deſtitute of language, as not to have words for common objects, and internal feelings; or, having theſe, that they ſhould lay them entirely aſide, and adopt the artificial names of the marks repreſenting thoſe objects and ideas in their ſteads. But they might eaſily adopt names, ſimple or compound, at firſt aſcribed artificially to marks, whoſe objects and ideas had before this adoption no names.

That in affixing names artificially to marks a great diverſity might ariſe, appears from the great diverſity of alphabetical characters expreſſing the ſame words. Thus the *Hebrew*, *Samaritan* and *Syriac* languages, agree nearly in ſound and ſenſe, but differ entirely in characters. Thus alſo, amongſt modern languages, ſeveral are written in different characters, as *Engliſh* in the common round-hand in various law hands, and various ſhort hands.

Let us now return to *Shem*, *Ham*, and *Japhet*, and their poſterity. They muſt be ſuppoſed to proceed in the ſame manner, in general, as *Noah*, and his immediate poſterity, till the confuſion of tongues at *Babel*; excepting that *Shem*, *Ham*, and *Japhet*, with their wives, would be more apt to alter their character and language, and ſuit them to their preſent exigencies, than *Noah* and his wife, on account of their being all young perſons; alſo that, being all as it were equal to each other they might each of them be the authors of certain diverſities in the common character and language and eſtabliſh them in their reſpective poſterities. However, if *Noah* be ſuppoſed to have continued with them till the diviſion of the earth by God's command, and then only to have departed with his poſtdiluvian poſterity for *China*, the country aſſigned to him, whilſt *Shem*, *Ham*, and *Japhet*, with their poſterity, began to build the tower of *Babel* in oppoſition to God's command, then *Noah*, and all his ſons, &c. muſt be ſuppoſed to have ſuited their character and language to the new world in nearly the ſame manner.

The confuſion of tongues at *Babel* appears to me to be miraculous for the following reaſons.

Firſt, This appears to be the moſt natural interpretation of the text.

Secondly, Thus the confuſion of tongues will correſpond to the gift of language imparted to *Adam* at his creation, which muſt be ſuppoſed; alſo to the gift of tongues at *Pentecoſt*.

Thirdly, Learned men ſeem to have ſhewn, that the diverſity of ancient languages does by no means favour the ſuppoſition of a natural derivation of them all from one original form.

Fourthly, The original plan of the *Greek* and *Latin* languages (which I conſider as ſiſter languages derived from the ſame mother or original plan), appears to have been very uniform, yet with a conſiderable variety. Now I think this uniformity and variety could ſcarce be invented and eſtabliſhed by rude multitudes, almoſt entirely occupied in providing neceſſaries for themſelves, and much leſs an alphabetical writing ſeems to be of later date than the diverſity of languages. And in fact we do not find, that barbarous nations do by length of time improve their languages ſo as in any meaſure to approach to the perfection of the *Greek* or *Latin*, or of their common mother. It adds ſtrength to this argument, that the original plan of the *Greek* and *Latin*, *i. e.* the rules of etymology and ſyntax, as grammarians call them, is entirely different from that of the *Hebrew* and *Arabic* (whoſe original plans agree), though the firſt colonies, which came by ſea into *Greece* and *Italy*, came from *Paleſtine* and *Egypt*, *i. e.* from the neighbourhood of countries where *Hebrew* and *Arabic* were ſpoken.

Fifthly, The natural deviation of languages ſince hiſtory has been clear and certain, does by no means correſpond to a ſuppoſed natural derivation of all languages from one mother-tongue, eſpecially in ſo ſhort a time as the interval between the flood and the riſe of many different ancient languages. Let the reader here only reflect upon the great difference of the Biblical *Hebrew* from the ancienteſt *Greek* extant, and the ſmall difference of this from modern *Greek*, or of the Biblical *Hebrew* from the Rabbinical.

If now the confuſion of tongues was miraculous, we may conjecture from the agreements and diſagreements of mother-languages from each other, that it was of the following kind.

Firſt, That the original monoſyllabic words of the antediluvian language were incorporated into each new language.

Secondly, That as theſe words included only few of the articulate ſounds of which the human voice is capable, the ſeveral families were put upon making new articulations, ſome having one ſet, ſome another, imparted to them.

Thirdly, That each family had a new ſtock of words given them, conſiſting partly of old, partly of new articulations; and that this new ſtock far exceeded the old one in number and variety.

Fourthly, That a new and different etymology and ſyntax were alſo communicated to each family.

Fifthly, That there were as many new languages given as there are heads of families mentioned *Gen.* x; the confuſion of tongues, by which the diviſion of the earth was effected, not happening till *Joktan*'s ſons were old enough to be heads of families, though it had been determined and declared by God before. Thoſe families, however, which were derived from the ſame ſtock, or had contiguous countries aſſigned to them, might be inſpired with languages, that had a proportionable affinity.

Whatever may become of theſe particular conjectures, I think it highly probable, that the new languages far exceeded the old common one in the number and variety of words; and that the confuſion of tongues was by this means a beneficial gift and bleſſing to mankind, as all God's other chaſtiſements uſe to be.

We may alſo ſee reaſons to make us judge, that a diverſity of languages is ſuited to the other circumſtances of mankind. For this muſt prevent the infection of vice from ſpreading with ſuch rapidity, as it would otherwiſe have done, had mankind lived together in one large body, and had a free communication with each other by means of the ſame language.

Diverſity of languages does alſo both help the invention, and correct falſe judgments. For we think in words, as appears by the foregoing theory, and invent chiefly by means of their analogies; at the ſame time that a ſervile adherence to thoſe of any one language, or the putting words for things, would lead us into many errors. Now diverſity of languages does both enlarge the field of invention, and by oppoſing analogy to analogy preſerve us from the prejudices derived from mere verbal agreements. Let me add here, that the abſtract terms of logicians, metaphyſicians, and ſchool-men, which may be conſidered as a diſtinct language, have ſpiritualized men's underſtandings, and taught them to uſe words in reaſoning, as algebraiſts do ſymbols.

Different languages do likewiſe improve one another, and help one another to grow in ſome proportion to the advancement in the knowledge of things.

Let us now examine the probable conſequences of ſuppoſing different languages, and ſuch as were far more copious than the old one, to be given at once miraculouſly.

Firſt, then, The character, which ſuited the old language very imperfectly, would be ſtill leſs ſuited to the new one.

Secondly, The new language might be more copious, and better adjuſted to expreſs objects and ideas, than the character. And this I think can ſcarce be doubted, if we ſuppoſe the new languages given miraculouſly.

Thirdly, The agreement between many of the marks of the character, and the words of the old language, may be ſuppoſed likely to put ſome perſons upon denoting the words of the new language by marks. But whether this would neceſſarily lead to alphabetical writing, is very doubtful. I think not. The firſt attempts at leaſt would not be alphabetical writing.

Fourthly, Perſons of different families, who could not underſtand one another's language, might yet correſpond by the character. However, one may gueſs from the circumſtances of things in ancient times, that this would ſeldom take place in fact.

Fifthly, This and the convenience of correſponding with perſons of the ſame family at a diſtance, alſo the deſire of preſerving memorials of remarkable events and tranſactions, might make them continue the uſe of the character, and improve it, conſidered as a method of conveying ideas, diſtinct from that of language. And the character thus ſeparated from the language might give riſe to hieroglyphical writing in all its varieties.

Sixthly, The patriarchs after the flood in the line of *Shem* might convey in ſucceſſion the hiſtory of the creation, fall, deluge, calling of *Abraham*, &c. either in the original picture-writing improved, or in the mixed character, which according to the third of theſe conſequences, denoted in ſome imperfect groſs way the words of the new language. And ſome of the difficulties of the book of *Geneſis* may be owing to its conſiſting of patriarchal records of one of theſe kinds, tranſlated by *Moſes* into the *Hebrew* of his own times, and then written alphabetically.

I do not think it *neceſſary* to have recourſe to any ſuch hypotheſis as this, in order to vindicate the truth and authority of the book of *Geneſis*. The length of life, even after the flood, to the time of *Moſes*, appears ſufficient for the preſervation of ſuch important traditional hiſtories uncorrupted in the religious line of *Shem*, by natural means. Or God might interpoſe miraculouſly, as in ſo many other inſtances in patriarchal times.

If it be objected, that we have not the leaſt intimation of writing of any kind in *Geneſis*, I anſwer, that this is a difficulty. However, one cannot draw any certain concluſions from an omiſſion. The original of writing is not likely to be one of the firſt things, which would be committed to writing. And if it was uſed only for the conveyance of important facts to the ſucceeding generations, we have no reaſon to expect the incidental mention of it. It was probably ſo tedious and difficult a thing to expreſs themſelves accurately in it, and verbal meſſages and contracts ſo eaſy and natural in thoſe ſimple ages, when the veracity of the meſſenger or contractor was not ſuſpected, as that writing was never uſed after the confuſion of tongues, when language became copious, unleſs in affairs of great conſequence.

Picture-writing is alluded to in the ſecond commandment, and muſt have been in uſe for ſome time before, ſince a ſyſtem of idolatry had been founded upon it. And this may incline one to think, that it had been chiefly employed in ſacred affairs, and therefore perhaps communicated originally to *Adam* by God. However, if we ſuppoſe, that it did not take place till after the flood, this will not totally vitiate the foregoing conjectures. The main purport of them may ſtand with due alterations and allowances. But it would be tedious to ſtate all the varieties in things of ſo uncertain a nature.

I come now to the art of alphabetical writing. This I conjecture to have been communicated miraculouſly by God to *Moſes* at *Sinai*, for the following reaſons, which, however, I do not judge to be deciſive ones.

Firſt, then, God is ſaid to have written with his own finger upon the tables of ſtone. And I think it would be harſh to ſuppoſe this done in conformity to, and, as one may ſay, imitation of, any mere imperfect human invention.

Secondly, The *Iſraelites* are the only people in the whole world that have preſerved any regular account of their own original. This is eaſily accounted for upon ſuppoſition, that alphabetical writing was firſt given to them in perfection; and afterwards, ſuppoſe in the time of *Eli*, borrowed by other nations, and accommodated in an imperfect manner to their languages. But if we ſuppoſe any other nation, the *Egyptians* or *Arabians* for inſtance, to have invented writing before the time of *Moſes*, it will be ſomewhat difficult to aſſign a reaſon, why other perſons ſhould not have borrowed this invention as well as *Moſes*, and, like him, have given ſome account of their own nation, and their anceſtors; and more difficult to aſſign a reaſon why the people, who invented alphabetical writing, ſhould not do this.

As to the *Egyptians* in particular, their continuing to uſe hieroglyphical writing, and excelling in it, ſhews, that they could not have invented alphabetical; for this, if we ſuppoſe it invented ſo early as before the time of *Moſes*, would have aboliſhed that, juſt as the uſe of the ten cyphers has all the other imperfect methods of notation of numbers. Nor does it ſeem very likely, that hieroglyphical writing ſhould lead to alphabetical, but rather from it, ſince hieroglyphical characters are the immediate repreſentatives of objects and ideas, and the mediate repreſentatives not of letters, or ſimple articulate ſounds, but of words, and even of cluſters of words. It ſeems probable alſo, that the *Egyptians* would even be backward in receiving alphabetical writing from the *Iſraelites* at the time that the *Philiſtines* or *Phœnicians* did; as being then greatly advanced in the uſe of their own hieroglyphical writing, and prejudiced in its favour. And thus we may ſolve that very difficult queſtion, why the *Egyptians*, who ſeem to have erected a kingdom early (however, I judge *Nimrod*'s to have been the firſt by the manner in which *Moſes* has mentioned it), and to have brought it to conſiderable perfection before *Joſeph*'s time, and to very great perfection afterwards, chiefly by his means, ſhould yet have left no hiſtory of their affairs, not even of the great empire under *Seſac* or *Seſoſtris*, and his ſucceſſors. For they had no public calamities ſufficient in any meaſure to deſtroy all their records, till the time of *Cambyſes*; and the deſolation under him being leſs in degree, ſhorter in duration, in a kingdom of greater extent, and two generations later in time, than that of the *Jewiſh* ſtate under *Nebuchadnezzar*, which yet did not deſtroy the *Jewiſh* records, could not have totally deſtroyed the *Egyptian* records had they been more early, and ſuperior to the *Jews*, in the uſe of alphabetical writing. Even the *Greeks*, who had no alphabetical writing till ſix hundred years after the time of *Moſes*, have given a better account of their affairs, than the *Egyptians*. It ought, however, to be remarked in this place, that if we ſuppoſe the *Jewiſh* hiſtory to have been recorded by the divine appointment and direction, which is highly probable, this will leſſen the force of the preſent argument, but not quite deſtroy it.

Thirdly, The late reception of writing amongſt the *Greeks*, is both an argument, that it did not exiſt in any other neighbouring nation before the time of *Moſes*, and alſo is conſiſtent with its being miraculouſly communicated to *him*, to be made uſe of for ſacred purpoſes, and for the preſervation of the hiſtory of the world, and true religion, amongſt God's peculiar people the *Iſraelites*. I here ſuppoſe, that the art of writing was not known to the *Greeks*, till the time of *Cadmus*; and that he came into *Greece*, agreeably to Sir *Iſaac Newton*'s opinion, about the middle of *David*'s reign. And indeed, unleſs the principal points of his chronology be admitted, it does not appear to me, that any *rationale* can be given of ancient times, the inventions that roſe up in them, the eſtabliſhment and duration of kingdoms, their mutual intercourſes, &c.

For, Firſt, If alphabetical writing was known upon the continent of *Aſia* and *Africa* ſix hundred years before *Cadmus*, how could it be kept from the *Greeks* till his arrival amongſt them, and then accommodated to the *Greek* tongue only very imperfectly? For the *Greeks* received but ſixteen letters from him. The *Greek* tongue came itſelf perhaps from *Egypt*, in ſome meaſure; and they who brought the language two generations before *Cadmus*, would have brought an exact method of writing it alphabetically, had they been poſſeſſed of any ſuch. For it is not probable, that *Inachus*, and the colonies of *Egyptians* that came with him, and after him, ſhould change their language entirely for that of the poor wandering *Cimmerians*, whom they found in *Greece*, ſince we ſee in fact, that the colonies of *Europeans* do ſometimes teach the barbarous natives, where they go, an *European* language; but never change it for theirs.

Secondly, If alphabetical writing was given to *Moſes* miraculouſly, it is eaſy to be conceived, that it ſhould not arrive at *Greece* ſooner than the time of *Cadmus*. For the *Jews* were a ſeparate people, their prieſts kept the writings of *Moſes* in the ark, *i. e.* the only alphabetical writings in the world; and muſt be ſome time before they could be ready and expert either in reading or writing: in their attempts to copy, it is probable they would make ſome miſtakes ſo as to fall ſhort of the purity and perfection of the art, as communicated by God; the neighbouring nations feared and hated the *Iſraelites*, their religion, and their God; they had probably a picture-writing, or perhaps ſome imperfect method of denoting words, agreeably to what has been remarked above, which anſwered all purpoſes that ſeemed neceſſary to them; and thus the art of alphabetical writing might not tranſpire to any of the neighbouring nations till the time of *Eli*, when the ark, with the writings of *Moſes* in it, was taken by the *Philiſtines*. For ſince the writings of *Moſes* were not in the ark, when it was put into the temple by *Solomon*, it may be, that the *Philiſtines* kept them, and learnt from them the art of writing alphabetically, being now ſufficiently prepared for it by ſuch notions concerning it, as had tranſpired to them previouſly in their former intercourſes with the *Iſraelites*. And thus the *Phœnicians*, or *Philiſtines*, will have appeared the inventors of letters to the *Greeks*; and *Cadmus* may well be ſuppoſed to have been able to accommodate the *Phœnician* method of writing, in an imperfect manner, to the *Greek* language, about two generations after the taking of the ark. Thus alſo, when *Samuel* put the writings of *Moſes* together, as they had been copied by the prieſts, or others, in the order in which they now ſtand in the Pentateuch, there would be ſome deviations from the original method of writing communicated to *Moſes* by God; and theſe, with ſuch as happened in after-times, particularly upon the return from the *Babyloniſh* captivity (when it is ſuppoſed by ſome, that even the original letters were changed), may have made the ancient method of writing the *Hebrew*, as the *Jews* practiſe it in their Bibles for the ſynagogues without points, ſo imperfect as not to appear to be of divine original. For the ſame reaſons, the corruptions of the *Hebrew* language, or the language given to *Heber* or *Peleg*, at the confuſion of tongues before *Moſes*'s time, may incline us to think the *Hebrew* of the Pentateuch not ſufficiently regular for a divine communication. Much is alſo to be aſcribed to our own ignorance in both theſe caſes. However, there is a wonderful ſimplicity and uniformity ſtill left, both in the Biblical *Hebrew*, and in the manner of writing it without points; ſo great, as to appear to me ſuperior to the invention of rude ancient times.

Fourthly, The order of the *Greek* and *Latin* alphabets, by being taken from that of the *Hebrew*, as we have it in the alphabetical pſalms, bears teſtimony to the great antiquity of the *Hebrew* alphabet. It is to be obſerved here, that both the *Greek* and *Latin* alphabets coincide with the *Hebrew* alphabet, as much as with each other, or more; and that there is no other ancient alphabet remaining to be a competitor to the *Hebrew*.

Fifthly, The reſolution of the complex articulate ſounds of ancient languages into ſimple elements or letters, and then recompoſing theſe complex ſounds in writing them down alphabetically, ſeems to me, as obſerved above, too difficult a problem for ancient times; eſpecially as they neither could ſee the uſe of it, nor conceive the practicability. It would have appeared to them a taſk of an infinite extent; they would never conceive, that ſo ſmall a number of elements would be ſufficient, even ſuppoſing they could firſt hit upon the deſign. It confirms this, that no barbarous nation has ever invented alphabetical writing for themſelves. They continue ignorant of it till taught. However, let it be obſerved, on the other hand, that as the ancient languages were ſimple and narrow, the difficulty of analyſing their complex ſounds would be the leſs on that account.

Sixthly, Since the method of making and erecting the tabernacle was communicated by God to *Moſes*, *Bezaleel*, and *Aholiab*, in a ſupernatural manner, we may more eaſily ſuppoſe the art of writing alphabetically to be a divine gift. But then it is ſome objection to this, that *Moſes* has not mentioned it as a divine gift, at leaſt not expreſsly.

Seventhly, The time of *Moſes* appears to be a ſuitable one for ſuch a gift, as human life was then, perhaps, juſt brought down to the preſent degree of ſhortneſs. Till *Moſes*'s time, the length of life had preſerved the ſacred traditions uncorrupted, either with or without the helps above-mentioned, at leaſt in the line of *Abraham*; but then tradition began to be mixed with fables, and to lead to idolatry.

Eighthly, Alphabetical writing, by being introduced among the *Iſraelites* in the wilderneſs, would aboliſh hieroglyphical, and conſequently cut off one ſource of idolatry. It would likewiſe make them ſuperior to the *Egyptians*, their enemies, in the art of writing; who, perhaps, prided themſelves much upon account of their perfection in hieroglyphical writing, as they might alſo in their river, the wiſdom of their policy, the comparative greatneſs of their kingdom, their magical arts, religious ceremonies, &c. For this would tend to the glory of the God of the *Iſraelites*, and the eſtabliſhment of the true religion amongſt them.

It may be objected here, that alphabetical writing was in uſe before the giving of the law at *Sinai*, ſince *Moſes* was directed before this to write an account of the battle with *Amalek* in a book; alſo to write the names of the children of *Iſrael* upon the high prieſt's breaſt-plate, like the engravings of a ſignet. I anſwer, that both theſe may refer to a picture-writing, or to ſome improvement of it, whereby entire words were denoted, without being reſolved into their ſimple ſounds. The firſt might alſo be a prophetic intimation to *Moſes*, however not underſtood by him when it was given, that he ſhould be ſoon enabled to write in a much more complete manner than he, or his enemies the *Egytians*, could at preſent.

The *Edomites* ſeem alſo to have had ſome kind of writing early, from the account which we have of their dukes in *Geneſis*. But this might be only picture or verbal writing, explained to *Samuel* by ſome *Edomite*, at the time when he put together the writings of *Moſes*: or they might learn writing from the *Iſraelites*, ſooner than any other nation, as being nearly related in blood, and contiguous to them in ſituation.

The ſimplicity and uniformity of the *Arabic* tongue would alſo incline one to think that the inhabitants of *Arabia* had alphabetical writing early, this having a great tendency to preſerve a fixed ſtandard in a language. But the *Iſhmaelites*, or *Midianites*, who were nearly related to the *Iſraelites*, or the *Kenites*, who lived amongſt them, might learn it from them, perhaps even during their abode in the wilderneſs. We may obſerve alſo, that the *Arabic* tongue was not only fixed, but perhaps rendered more regular, ſoon after the time of *Mahomet*, by means of the *Alcoran*, and of the grammars that were made for this language ſome time afterwards; and that, before *Mahomet*'s time the *Arabians* had little communication with their neighbours, and therefore would preſerve their language more pure and ſimple.

The changes which have happened to languages, and to the methods of writing them ſince the invention of letters, and which are treated of with great copiouſneſs in the writings of grammarians and critics, afford innumerable atteſtations to the doctrine of aſſociation, and may, converſely, be much illuſtrated by it. But the full detail of this muſt be left to thoſe, who are well ſkilled in the ſeveral ancient and modern languages.

PROP. LXXXIV.

To explain the general Nature of a philoſophical Language, and hint ſome Methods, in which it might be conſtructed, upon the foregoing Principles.

If we ſuppoſe mankind poſſeſſed of ſuch a language, as that they could at pleaſure denote all their conceptions adequately, *i.e.* without any deficiency, ſuperfluity, or equivocation; if, moreover, this language depended upon a few principles aſſumed, not arbitrarily, but becauſe they were the ſhorteſt and beſt poſſible, and grew on from the ſame principles indefinitely, ſo as to correſpond to every advancement in the knowledge of things, this language might be termed a philoſophical one, and would as much exceed any of the preſent languages, as a paradiſiacal ſtate does the mixture of happineſs and miſery, which has been our portion ever ſince the fall. And it is no improbable ſuppoſition, that the language given by God to *Adam* and *Eve*, before the fall, was of this kind; and, though it might be narrow, anſwered all their exigencies perfectly well.

Now there are ſeveral methods, in which it does not ſeem impoſſible for mankind in future ages to accompliſh ſo great a deſign.

Thus, Firſt, They may examine all the poſſible ſimple articulations of which their organs are capable, with all the combinations, or complex articulate ſounds, that reſult from them, and the relations which theſe bear one to another, and aſſign to each reſpectively ſuch ſimple and complex ideas, and ſuch variations of the laſt, as a deep inſight into the nature of things, objects, ideas, the powers of the human mind, &c. ſhall demand by a natural claim, ſo as to make every expreſſion the ſhorteſt and beſt poſſible. And though this, in our preſent ſtate of ignorance, cannot but ſeem an impracticable project, yet the ſame ignorance ſhould teach us, that we can form no notions at all of the great increaſe of knowledge, which may come in future ages, and which ſeems promiſed to come in the latter happy times predicted by the prophecies. However, the great, and to former times inconceivable, advancement of knowledge, which has been made in the two laſt centuries, may help a little to qualify our prejudices.

Secondly, If all the ſimple articulate ſounds, with all the radical words, which are found in the preſent languages, were appropriated to objects and ideas agreeably to the preſent ſenſes of words, and their fitneſs to repreſent objects and ideas, ſo as to make all conſiſtent with itſelf; if, farther, the beſt rules of etymology and ſyntax were ſelected from the preſent languages, and applied to the radical words here ſpoken of, ſo as to render them capable of expreſſing all the variations in objects and ideas, as far as poſſible, *i. e.* ſo as to grow proportionably to the growth of knowledge, this might alſo be termed a philoſophical language; and, though more imperfect and narrow than the laſt, yet ſeems more poſſible to be brought to execution and practice.

Thirdly, If ſuch ſimple articulations as are now wanting in the *Hebrew* alphabet were added to it, and its radical words, compoſed of all the combinations of twos and threes completed, proper ſimple ſenſes being aſſigned to them, from other languages ſuppoſe, and particularly from the *Arabic*, *Chaldee*, *Syriac*, and *Samaritan*, as in *Caſtellus*'s Lexicon, and other books of a like kind; if, farther, ſuch new rules of etymology and ſyntax were added to thoſe which take place at preſent in the Biblical *Hebrew*, as this increaſe of the radicals, and application of the language to the whole aggregate of objects and ideas requires; we ſhould have a much more ſimple, preciſe and extenſive language, than any now in being. It would alſo be eaſy to be underſtood by the *Jews* in all quarters of the world. For moſt of them have ſome knowledge of the Biblical *Hebrew*, and many underſtand the Rabbinical, which ſeems to be formed upon a plan not very unlike that here propoſed, though without any expreſs deſign; and to which, therefore, a due regard ought to be had by any one, who ſhould attempt to execute this plan. Many eaſtern nations, and the *Mahometans* every where, would alſo be expert in learning this language, from the relation and reſemblance which it would bear to languages already known by them; and it would be eaſier to be learnt by perfect novices than any other, on account of its greater ſimplicity and regularity. A dictionary might be made for it in itſelf; the Biblical *Hebrew*, where its ſenſe is determinate and known, being the baſis, or thing given.

In the mean time, where the writer endeavours to expreſs himſelf with plainneſs, ſincerity, and preciſion,

ciſion, being firſt duly qualified by the knowledge of his ſubject, and the reader pays a due regard to him, as his teacher, for the then preſent time, by uſing ſufficient induſtry and candour, the ill effects of the confuſion of tongues become evaneſcent in reſpect of them. But it would be happy to take away all occaſion of miſtake from the bulk of mankind, and to give them an opportunity of learning important truths with more eaſe and certainty, and in a ſhorter time, than they can at preſent.

It may not be amiſs to add here, that Mr. *Byrom*'s method of ſhort-hand affords an accurate and elegant inſtance of the poſſibility of proceeding in ſuch matters upon ſimple and philoſophical principles; his ſhort-hand being a real and adequate repreſentation of the ſounds of the *Engliſh* tongue, as far as is neceſſary for determining the ſenſe, and that in the ſhorteſt manner poſſible. If we were poſſeſſed of a philoſophical language, it ought to be denoted by this character, *mutatis mutandis.*

PROP. LXXXV.

To illuſtrate and confirm the general Doctrine of Aſſociation by the particular Aſſociations, that take Place in reſpect of Language.

THIS has been done, in great meaſure, already, in the corollaries to the twelfth propoſition. I will here inſert ſome obſervations of a like kind, which would have interrupted the reader too much in that place, but may properly follow the account of language given in this ſection.

Let *a*, *b*, *c*, *d*, &c. the ſeveral letters of an alphabet ſuppoſed to be ſufficiently extenſive for the purpoſe, repreſent reſpectively the ſeveral ſimple ſenſible pleaſures and pains, to which a child becomes ſubject upon its firſt entrance into the world. Then will the various combinations of theſe letters repreſent the various combinations of pleaſures and pains, formed by the events and incidents of human life; and, if we ſuppoſe them to be alſo the words of a language, this language will be an emblem or adumbration of our paſſage through the preſent life; the ſeveral particulars in this being repreſented by analogous ones in that.

Thus the reiterated impreſſions of the ſimple ſenſible pleaſures and pains made upon the child, ſo as to leave their miniatures, or ideas, are denoted by his learning the alphabet; and his various aſſociations of theſe ideas, and of the pleaſures and pains themſelves, by his putting letters and ſyllables together, in order to make words: and when aſſociation has ſo far cemented the component parts of any aggregate of ideas, pleaſures and pains, together, as that they appear one indiviſible idea, pleaſure or pain, the child muſt be ſuppoſed by an analogous aſſociation to have learnt to read without ſpelling.

As the child's words become more and more polyſyllabic by compoſition and decompoſition, till at length whole cluſters run together into phraſes and ſentences, all whoſe parts occur at once, as it were, to the memory, ſo his pleaſures and pains become more and more complex by the combining of combinations; and in many caſes numerous combinations concur to form one apparently ſimple pleaſure.

The ſeveral relations of words, as derived from the ſame root, as having the ſame prepoſitions and terminations, &c. repreſent correſponding relations in the compound ideas, pleaſures and pains.

When the complex pleaſures and pains, formed from miniatures of the ſenſible ones, become the means of gaining other and greater pleaſures, viz. by fading from frequent repetition, and ſo becoming mere ideas, or by any other method, we muſt ſuppoſe, that our preſent knowledge in language is uſed as a means of attaining farther knowledge in it.

As the ſight and ſound of words, impreſſed upon us on common occaſions, do not at all ſuggeſt the original of theſe words from ſimple letters, this being a light in which grammarians and linguiſts alone conſider words, ſo the complex pleaſures and pains may paſs over men's minds, and be felt daily, and yet not be conſidered by them as mere combinations, unleſs they be peculiarly attentive and inquiſitive in this reſpect.

This compariſon may ſerve as a method of aſſiſting the reader's conceptions, in reſpect of the manner in which combinations of miniatures are formed. It is alſo a conſiderable evidence in favour of the general doctrine of aſſociation, ſince language is not only a type of theſe aſſociated combinations, but one part of the thing typified. Was human life perfect, our happineſs in it would be properly repreſented by that accurate knowledge of things which a truly philoſophical language would give us. And if we ſuppoſe a number of perſons thus making a progreſs in pure unmixed happineſs, and capable both of expreſſing their own feelings, and of underſtanding thoſe of others, by means of a perfect and adequate language, they might be like new ſenſes and powers of perception to each other, and both give to and receive from each other happineſs indefinitely. But as human life is, in fact, a mixture of happineſs and miſery, ſo all our languages muſt, from the difference of our aſſociations, convey falſehood as well as truth, as above noted. And yet, ſince our imperfect languages improve, purify, and correct themſelves perpetually by themſelves, and by other means, ſo that we may hope at laſt to obtain a language, which ſhall be an adequate repreſentation of ideas, and a pure channel of conveyance for truth, alone, analogy ſeems to ſuggeſt, that the mixture of pleaſures and pains, which we now experience, will gradually tend to a collection of pure pleaſures only, and that aſſociation may be the means of effecting this, as remarked in the ninth corollary of the fourteenth propoſition.

SCHOLIUM.

Muſical ſounds afford, like articulate ones, various inſtances of the power of aſſociation. It ought to be remarked here alſo, that the concords formed from the twelve ſemitones in the octave, are more in number than the diſcords; and that the harſhneſs of theſe laſt paſſes by degrees into the limits of pleaſure, partly from frequent repetition, partly from their aſſociations with concords.

The doctrine of aſſociation may likewiſe be illuſtrated by that of colours. Thus, let the ſeven primary colours, with their ſhades, repreſent the original ſenſible pleaſures; then will the various aſſociated pleaſures of human life, ſuppoſing that we enjoyed a ſtate of unmixed happineſs, be repreſented by the compound vivid colours, which natural bodies, of regular makes, and ſtrong powers of reflection, exhibit to the eye. White, which is compounded of all the colours reflected copiouſly, and which yet, as far as the eye can diſcern, bears no reſemblance to any of them, would repreſent a ſtate of great mental happineſs, ultimately deduced from all the ſenſible pleaſures, and in which notwithſtanding, the perſon himſelf diſtinguiſhes no traces of any of theſe. And, agreeably to this, light, brightneſs, and whiteneſs, are often put for perfection, purity, and happineſs, as obſcurity, blackneſs, and darkneſs, are for imperfection and miſery. Beſides white, there are other compound colours, which bear little or no reſemblance to any of the primary ones, as well as many in which ſome primary colour is evidently predominant. Theſe repreſent the ſeveral kinds and degrees of inferior compound pleaſures, ſome of which are, according to common eſtimation, quite foreign to the ſenſes, whilſt others are manifeſtly tinged with pleaſant ſenſations, and their miniatures.

If the moderate agitations which light cauſes in bodies, when it is by them reflected back upon, or tranſmitted to other bodies, be ſuppoſed to correſpond to pleaſant vibrations in the nervous ſyſtem; and the greater agitations, which it excites in thoſe that abſorb it, to the violent vibrations in which pain conſiſts; then the colours of natural bodies, ſome of which incline to light, and ſome to darkneſs, and that with all the poſſible varieties and mixtures of the primary colours, may be conſidered as the language by which they expreſs that mixture of pleaſures and pains in human life, to which their agitations are ſuppoſed to correſpond. And here again we may obſerve, that though there are ſome natural bodies, which abſorb and ſtifle within themſelves almoſt all the light which they receive, and which accordingly are dark, black, and unpleaſant to the beholders, yet the greateſt part of natural bodies either reflect lively colours, or reflect ſome, and tranſmit others, or tranſmit all the colours freely. And this type is alſo, in part, the thing typified, inaſmuch as agreeable and diſagreeable colours make part of the original pleaſures and pains of human life.

Compound taſtes may likewiſe illuſtrate aſſociation; as above noted under the twelfth propoſition: for where the number of ingredients is very great, as in Venice treacle, no one can be taſted diſtinctly; whence the compound appears to bear no relation to its component parts. It is to be obſerved farther, that ingredients which are ſeparately diſagreeable, often enter compounds, whoſe taſtes are highly agreeable. Now in theſe caſes either the oppoſite taſtes muſt coaleſce into one, which pleaſes from the propollence of agreeable taſtes upon the whole, as ſoon as the aſſociation is cemented ſufficiently, or elſe the diſagreeable taſtes muſt, by frequent repetition, fall within the limits of pleaſure at laſt; which ſeems rather to be the truth.

The ſimilarity of the three inſtances of this ſcholium ariſes from the analogy of our ſenſes to each other, and to our frame in general; which is the ſum total of all our ſenſes. And, converſely, they confirm this analogy.

SECT. II.

OF PROPOSITIONS, AND THE NATURE OF ASSENT.

PROP. LXXXVI.

To explain the Nature of Aſſent and Diſſent, and to ſhew from what Cauſes they ariſe.

It appears from the whole tenor of the laſt ſection, that aſſent and diſſent, whatever their preciſe and particular nature may be, muſt come under the notion of ideas, being only thoſe very complex internal feelings, which adhere by aſſociation to ſuch cluſters of words as are called *propoſitions* in general, or affirmations and negations in particular. The ſame thing is remarked in the tenth corollary to the twelfth propoſition.

But in order to penetrate farther into this difficult and important point, I will diſtinguiſh aſſent (and by conſequence its oppoſite, diſſent) into two kinds, rational and practical; and define each of theſe.

Rational aſſent then to any propoſition may be defined a readineſs to affirm it to be true, proceeding from a cloſe aſſociation of the ideas ſuggeſted by the propoſition, with the idea, or internal feeling, belonging to the word truth; or of the terms of the propoſition with the word truth. Rational diſſent is the oppoſite to this. This aſſent might be called verbal; but as every perſon ſuppoſes himſelf always to have ſufficient reaſon for ſuch readineſs to affirm or deny, I rather chooſe to call it rational.

Practical aſſent is a readineſs to act in ſuch manner as the frequent vivid recurrency of the rational aſſent diſpoſes us to act; and practical diſſent the contrary.

Practical aſſent is therefore the natural and neceſſary conſequence of rational, when ſufficiently impreſſed. There are, however, two cautions to be ſubjoined here, viz. Firſt, That ſome propoſitions, mathematical ones for inſtance, admit only of a rational aſſent, the practical not being applied to them in common caſes. Secondly, That the practical aſſent is ſometimes generated, and arrives at a high degree of ſtrength, without any previous rational aſſent; and by methods that have little or no connection with it. Yet ſtill it is in general, much influenced by it, and, converſely, exerts a great influence upon it. All this will appear more clearly when we come to the inſtances.

Let us next inquire into the cauſes of rational and practical aſſent, beginning with that given to mathematical concluſions.

Now the cauſe that a perſon affirms the truth of the propoſition, *twice two is four*, is the entire coincidence of the viſible or tangible idea of twice two with that of four, as impreſſed upon the mind by various objects. We ſee every where, that twice two and four are only different names for the ſame impreſſion. And it is mere aſſociation which appropriates the word truth, its definition, or its internal feeling, to this coincidence.

Where the numbers are ſo large, that we are not able to form any diſtinct viſible ideas of them, as when we ſay, that 12 times 12 is equal to 144; a coincidence of the words ariſing from ſome method of reckoning up 12 times 12, ſo as to conclude with 144, and reſembling the coincidence of words which attends the juſt-mentioned coincidence of ideas in the ſimpler numerical propoſitions, is the foundation of our rational aſſent. For we often do, and might always verify the ſimpleſt numerical propoſitions by reckoning up the numbers. The operations of addition, ſubtraction, multiplication, diviſion, and extraction of roots, with all the moſt complex ones relating to algebraic quantities, conſidered as the exponents of numbers, are no more than methods of producing this coincidence of words, founded upon and riſing above one another. And it is mere aſſociation again, which appropriates the word truth to the coincidence of the words, or ſymbols, that denote the numbers.

It is to be remarked, however, that this coincidence of words is, by thoſe who look deeper into things, ſuppoſed to be a certain argument, that the viſible ideas of the numbers under conſideration, as of 12 times 12, and 144, would coincide, as much as the viſible ideas of twice two and four, were they as clear and diſtinct. And thus the real and abſolute truth is ſaid by ſuch perſons to be as great in complex numerical propoſitions, as in the ſimpleſt. All this agrees with what Mr. *Locke* has obſerved concerning numbers, viz. that their names are neceſſary in order to our obtaining diſtinct ideas of them; for by diſtinct ideas he muſt be underſtood to mean proper methods of diſtinguiſhing them from one another, ſo as to reaſon juſtly upon them. He cannot mean diſtinct viſible ideas.

In geometry there is a like coincidence of lines, angles, ſpaces, and ſolid contents, in order to prove them equal in ſimple caſes. Afterwards, in complex caſes, we ſubſtitute the terms whereby equal things are denoted for each other, alſo the coincidence of the terms, for that of the viſible ideas, except in the new ſtep advanced in the propoſition; and thus get a new equality, denoted by a new coincidence of terms. This reſembles the addition of unity to any number, in order to make the next, as of 1 to 20, in order to make 21. We have no diſtinct viſible idea, either of 20 or 21; but we have of the difference between them, by fancying to ourſelves a confuſed heap of things ſuppoſed or called 20 in number; and then farther fancying 1 to be added to it. By a like proceſs in geometry we arrive at the demonſtration of the moſt complex propoſitions.

The properties of numbers are applied to geometry in many caſes, as when we demonſtrate a line or ſpace to be half or double of any other, or in any other rational proportion to it.

And as in arithmetic words ſtand for indiſtinct ideas, in order to help us to reaſon upon them as accurately as if they were diſtinct; alſo cyphers for words, and letters for cyphers, both for the ſame purpoſe; ſo letters are put for geometrical quantities alſo, and the agreements of the firſt for thoſe of the laſt. And thus we ſee the foundation upon which the whole doctrine of quantity is built; for all quantity is expounded either by number or extenſion, and their common and ſole exponent is algebra. The coincidence of ideas is the foundation of the rational aſſent in ſimple caſes; and that of ideas and terms together, or of terms alone, in complex ones. This is upon ſuppoſition that the quantities under conſideration are to be proved equal. But, if they are to be proved unequal, the want of coincidence anſwers the ſame purpoſe. If they are in any numeral ratio, this is only the introduction of a new coincidence. Thus, if, inſtead of proving *A* to be equal to *B*, we are to prove it equal to half *B*, the two parts of *B* muſt coincide with each other, either in idea or terms, and *A* with one.

And thus it appears, that the uſe of words is neceſſary for geometrical and algebraical reaſonings, as well as for arithmetical.

We may ſee alſo, that aſſociation prevails in every part of the proceſſes hitherto deſcribed.

But theſe are not the only cauſes of giving rational aſſent to mathematical propoſitions; as this is defined above. The memory of having once examined and aſſented to each ſtep of a demonſtration, the authority of an approved writer, &c. are ſufficient to gain our aſſent, though we underſtand no more than the import of the propoſition; nay, even though we do not proceed ſo far as this. Now this is mere aſſociation again; this memory, authority, &c. being, in innumerable inſtances, aſſociated with the beforementioned coincidence of ideas and terms.

But here a new circumſtance ariſes. For memory and authority are ſometimes found to miſlead; and this oppoſite coincidence of terms puts the mind into a ſtate of doubt, ſo that ſometimes truth may recur, and unite itſelf with the propoſition under conſideration, ſometimes falſehood, according as the memory, authority, &c. in all their peculiar circumſtances, have been aſſociated with truth or falſehood. However, the foundation of aſſent is ſtill the ſame. I here deſcribe the fact only. And yet, ſince this fact muſt always follow from the fixed immutable laws of our frame, the obligation to aſſent (whatever be meant by this phraſe) muſt coincide with the fact.

And thus a mathematical propoſition, with the rational aſſent or diſſent ariſing in the mind, as ſoon as it is preſented to it, is nothing more than a group of ideas, united by aſſociation, *i. e.* than a very complex idea, as was affirmed above of propoſitions in general. And this idea is not merely the ſum of the ideas belonging to the terms of the propoſition, but alſo includes the ideas, or internal feelings, whatever they be, which belong to equality, coincidence, truth, and, in ſome caſes, thoſe of utility, importance, &c.

For mathematical propoſitions are, in ſome caſes, attended with a practical aſſent, in the proper ſenſe of theſe words; as when a perſon takes this or that method of executing a projected deſign, in conſequence of ſome mathematical propoſition aſſented to from his own examination, or on the authority of others. Now, that which produces the train of voluntary actions, here denoting the practical aſſent, is the frequent recurrency of ideas of utility and importance. Theſe operate according to the method ſaid down in the twentieth propoſition, *i. e.* by aſſociation; and though the rational aſſent be a previous requiſite, yet the degree of the practical aſſent is proportional to the vividneſs of theſe ideas; and in moſt caſes they ſtrengthen the rational aſſent by a reflex operation.

Propoſitions concerning natural bodies are of two kinds, vulgar and ſcientifical. Of the firſt kind are, *that milk is white, gold yellow, that a dog barks,* &c. Theſe are evidently nothing but forming the preſent complex idea belonging to material objects into a propoſition, or adding ſome of its common aſſociates, ſo as to make it more complex. There is ſcarce room for diſſent in ſuch propoſitions, they being all taken from common appearances. Or if any doubt ſhould ariſe, the matter muſt be conſidered ſcientifically. The aſſent given to theſe propoſitions ariſes from the aſſociations of the terms, as well as of the ideas denoted by them.

In ſcientifical propoſitions concerning natural bodies a definition is made, as of gold from its properties, ſuppoſe its colour, and ſpecific gravity, and another property or power joined to them, as a conſtant or common aſſociate. Thus gold is ſaid to be ductile, fixed, or ſoluble in *aqua regia.* Now to perſons, who have made the proper experiments a ſufficient number of times, theſe words ſuggeſt the ideas which occur in thoſe experiments, and, converſely, are ſuggeſted by them, in the ſame manner as the vulgar propoſitions above-mentioned ſuggeſt and are ſuggeſted by common appearances. But then, if they be ſcientifical perſons, their readineſs to affirm, that gold is ſoluble in *aqua regia* univerſally, ariſes alſo from the experiments of others, and from their own and other's obſervations on the conſtancy and tenor of nature. They know, that the colour, and ſpecific gravity, or almoſt any two or three remarkable qualities of any natural body, infer the reſt, being never found without them. This is a general truth; and as theſe general terms are obſerved to coincide, in fact, in a great variety of inſtances, ſo they coincide at once in the imagination, when applied to gold, or any other natural body, in particular. The coincidence of general terms is alſo obſerved to infer that of the particular caſes in many inſtances, beſides thoſe of natural bodies; and this unites the ſubject and predicate of the propoſition, *gold is ſoluble in aqua regia*, farther in thoſe who penetrate ſtill deeper into abſtract ſpeculations. And hence we may ſee, as before, Firſt, That terms or words are abſolutely neceſſary to the art of reaſoning; Secondly, That our aſſent is here alſo, in every ſtep of the proceſs, deducible from aſſociation.

The propoſitions formed concerning natural bodies are often attended with a high degree of practical aſſent, ariſing chiefly from ſome ſuppoſed utility and importance, and which is no ways proportional to the foregoing, or other ſuch like allowed cauſes of rational aſſent. And in ſome caſes the practical aſſent takes place before the rational. But then, after ſome time, the rational aſſent is generated and cemented moſt firmly by the prevalence of the practical. This proceſs is particularly obſervable in the regards paid to medicines, *i. e.* in the rational and practical aſſent to the propoſitions concerning their virtues.

It is to be obſerved, that children, novices, unlearned perſons, &c. give, in many caſes, a practical aſſent upon a ſingle inſtance; and that this ariſes from the firſt and ſimpleſt of the aſſociations here conſidered. The influence of the practical aſſent over the rational ariſes plainly from their being joined together in ſo many caſes. The vividneſs of the ideas ariſing from the ſuppoſed utility, importance, &c. does alſo unite the ſubject and predicate ſooner and cloſer, agreeably to what has been obſerved in the general account of aſſociation.

The evidences for paſt facts are a man's own memory, and the authority of others. Theſe are the uſual aſſociates of true paſt facts, under proper reſtrictions, and therefore beget the readineſs to affirm a paſt fact to be true, *i. e.* the rational aſſent. The integrity and knowledge of the witneſſes, being the principal reſtriction, or requiſite, in the accounts of paſt facts, become principal aſſociates to the aſſent to them; and the contrary qualities to diſſent.

If it be aſked, how a narration of an event, ſuppoſed to be certainly true, ſuppoſed doubtful, or ſuppoſed entirely fictitious, differs in its effect upon the mind, in the three circumſtances here alleged, the words being the ſame in each, I anſwer, firſt, in having the terms *true*, *doubtful*, and *fictitious*, with a variety of uſual aſſociates to theſe, and the correſponding internal feelings of reſpect, anxiety, diſlike, &c. connected with them reſpectively; whence the whole effects, exerted by each upon the mind, will differ conſiderably from one another. Secondly, If the event be of an intereſting nature, as a great advantage accruing, the death of a near friend, the affecting related ideas will recur oftener, and, by ſo recurring agitate the mind more, in proportion to the ſuppoſed truth of the event. And it confirms this, that the frequent recurrency of an intereſting event, ſuppoſed doubtful, or even fictitious, does, by degrees, make it appear like a real one, as in reveries, reading romances, ſeeing plays, &c. The affection of mind may be called the practical aſſent to paſt facts; and it frequently draws after it the rational, as in the other inſtances above alleged.

The evidence for future facts is of the ſame kind with that for the propoſitions concerning natural bodies, being like it, taken from induction and analogy. This is the cauſe of the rational aſſent. The practical depends upon the recurrency of the ideas, and the degree of agitation produced by them in the mind. Hence reflection makes the practical aſſent grow for a long time after the rational is ariſen to its height; or if the practical ariſes without the rational, in any conſiderable degree, which is often the caſe, it will generate the rational. Thus the ſanguine are apt to believe and aſſert what they hope; and the timorous what they fear.

There are many ſpeculative, abſtracted propoſitions in logic, metaphyſics, ethics, controverſial divinity, &c. the evidence for which is the coincidence or analogy of the abſtract terms, in certain particular applications of them, or as conſidered in their grammatical relations. This cauſes the rational aſſent. As to the practical aſſent or diſſent, it ariſes from the ideas of importance, reverence, piety, duty, ambition, jealouſy, envy, ſelf-intereſt, &c. which intermix themſelves in theſe ſubjects, and, by doing ſo, in ſome caſes add great ſtrength to the rational aſſent; in others deſtroy it, and convert it into its oppoſite.

And thus it appears, that rational aſſent has different cauſes in propoſitions of different kinds, and practical likewiſe; that the cauſes of rational are alſo different from thoſe of practical; that there is however, a great affinity, and general reſemblance, in all the cauſes; that rational and practical aſſent exert a perpetual reciprocal effect upon one another; and conſequently, that the ideas belonging to aſſent and diſſent, and their equivalents and relatives, are highly complex ones, unleſs in the caſes of very ſimple propoſitions, ſuch as mathematical ones. For, beſides the coincidence of ideas and terms, they include in other caſes, ideas of utility, importance, reſpect, diſreſpect, ridicule, religious affections, hope, fear, &c. and bear ſome groſs general proportion to the vividneſs of theſe ideas.

Cor. 1. When a perſon ſays *video meliora proboque, deteriora ſequor*; it ſhews that the rational and practical aſſent are at variance, that they have oppoſite cauſes, and that neither of theſe has yet deſtroyed the other.

Cor. 2. The rational and practical faith in religious matters are excellent means of begetting each other.

Cor. 3. Vicious men, *i. e.* all perſons who want practical faith, muſt be prejudiced againſt the hiſtorical and other rational evidences in favour of revealed religion.

Cor. 4. It is impoſſible any perſon ſhould be ſo ſceptical, as not to have the complex ideas denoted by aſſent and diſſent aſſociated with a great variety of propoſitions, in the ſame manner, as in other perſons; juſt as he muſt have the ſame ideas in general affixed to the words of his native language, as other men have. A pretended ſceptic is therefore no more than a perſon who varies from the common uſage in his application of a certain ſet of words, viz. truth, certainty, aſſent, diſſent, &c.

Cor. 5. As there is a foundation for unity amongſt mankind in the uſe and application of words, ſo there is for a unity in the aſſent, or complex ideas belonging to propoſitions; and a philoſophical language, or any other method of bringing about the firſt unity, would much conduce to this. A careful examination of things, of the world natural, the human mind, the ſcriptures, would conduce much alſo. But candour, ſimplicity, and an humble ſenſe of our own ignorance, which may be called a religious or chriſtian ſcepticiſm, is the principal requiſite, and that without which this part of the confuſion at *Babel* can never be remedied. When religion has equally and fully abſorbed different perſons, ſo that God is, in reſpect of them, *all in all*, as far as the preſent condition of mortality will permit, their practical aſſent muſt be the ſame; and therefore their rational cannot differ long or widely.

The ideas and internal feelings which ariſe in the mind, from words and propoſitions, may be compared to, and illuſtrated by, thoſe which the appearances of different perſons excite. Suppoſe two perſons, *A* and *B*, to go together into a crowd, and there each of them to ſee a variety of perſons whom he knew in different degrees, as well as many utter ſtrangers. *A* would not have the ſame ideas, and aſſociations raiſed in him from viewing the ſeveral faces, dreſſes, &c. of the perſons in the crowd, as *B*, partly from his having a different knowledge of, and acquaintance with them; partly from different prediſpoſitions to approve and diſapprove. But let *A* and *B* become equally acquainted with them and acquire, by education and aſſociation, the ſame prediſpoſitions of mind, and then they will at laſt make the ſame judgment of each of the perſons whom they ſee.

Cor. 6. Religious controverſies concerning abſtract propoſitions ariſe generally from the different degrees of reſpect paid to terms and phraſes, which conduce little or nothing to the generation of practical faith, or of love to God, and truſt in him through Chriſt.

PROP.

PROP. LXXXVII.

To deduce Rules for the Aſcertainment of Truth, and Advancement of Knowledge, from the mathematical Methods of conſidering Quantity.

THIS is done in the doctrine of chances, with reſpect to the events there conſidered. And though we ſeldom have ſuch preciſe *data*, in mixed ſciences as are there aſſumed, yet there are two remarks of very general uſe and application, deducible from the doctrine of chances.

Thus, Firſt, If the evidences brought for any propoſition, fact, &c. be dependent on each other, ſo that the firſt is required to ſupport the ſecond, the ſecond to ſupport the third, &c. *i. e.* if a failure of any one of the evidences renders all the reſt of no value, the ſeparate probability of each evidence muſt be very great, in order to make the propoſition credible; and this holds ſo much the more, as the dependent evidences are more numerous. For inſtance, if the value of each evidence be $\frac{1}{a}$, and the number of evidences be n, then will the reſulting probability be $\frac{1}{a^n}$. I here ſuppoſe abſolute certainty to be denoted by 1; and conſequently, that a can never be leſs than 1. Now it is evident, that $\frac{1}{a^n}$ decreaſes with every increaſe both of a and n.

Secondly, If the evidences brought for any propoſition, fact, &c. be independent on each other, *i. e.* if they be not neceſſary to ſupport each other, but concur, and can, each of them, when eſtabliſhed upon its own proper evidences, be applied directly to eſtabliſh the propoſition, fact, &c. in queſtion, the deficiency in the probability of each muſt be very great, in order to render the propoſition perceptibly doubtful; and this holds ſo much the more, as the evidences are more numerous. For inſtance, if the evidences be all equal, and the common deficiency in each be $\frac{1}{a}$, if alſo the number of evidences be n as before, the deficiency of the reſulting probability will be no more than $\frac{1}{a^n}$, which is practically nothing, where a and n are conſiderable. Thus if a and n be each equal to 10, $\frac{1}{a^n}$ will be $\frac{1}{10,000,000,000}$, or only 1 in ten thouſand millions; a deficiency from certainty, which is utterly imperceptible to the human mind.

It is indeed evident, without having recourſe to the doctrine of chances, that the dependency of evidences makes the reſulting probability weak, their independency ſtrong. Thus a report paſſing from one original author through a variety of ſucceſſive hands loſes much of its credibility, and one atteſted by a variety of original witneſſes gains, in both caſes, according to the number of ſucceſſive reporters, and original witneſſes, though by no means proportionably thereto. This is the common judgment of mankind, verified by obſervation and experience. But the mathematical method of conſidering theſe things is much more preciſe and ſatisfactory, and differs from the common one, juſt as the judgment made of the degrees of heat by the thermometer does from that made by the hand.

We may thus alſo ſee in a ſhorter and ſimpler way, that the reſulting probability may be ſufficiently ſtrong in dependent evidences, and of little value in independent ones, according as the ſeparate probability of each evidence is greater or leſs. Thus the principal facts of ancient hiſtory are not leſs probable practically now, than ten or fifteen centuries ago, nor leſs ſo then, than in the times immediately ſucceeding; becauſe the diminution of evidence in each century is imperceptible. For, if $\frac{1}{a}$ be equal to 1, $\frac{1}{a^n}$ will be equal to 1 alſo; and if the deficiency of $\frac{1}{a}$ from 1 be extremely ſmall, that of $\frac{1}{a^n}$ will be extremely ſmall alſo, unleſs n be extremely great. And for the ſame reaſon a large number of weak arguments proves little; for $\frac{1}{a}$ the deficiency of each argument, being extremely great, $\frac{1}{a^n}$, the reſulting deficiency of independent evidences, will be extremely great alſo.

It appears likewiſe, that the inequality of the ſeparate evidences does not much affect this reaſoning. In like manner, if the number of evidences, dependent or independent, be great, we may make great conceſſions as to the ſeparate values of each. Again, a ſtrong evidence in dependent ones can add nothing, but muſt weaken a little; and, after a point is well ſettled by a number of independent ones, all that come afterwards are uſeleſs, becauſe they can do no more than remove the imperceptible remaining deficiency, &c. And it will be of great uſe to purſue theſe, and ſuch like deductions, both mathematically, and by applying them to proper inſtances ſelected from the ſciences, and from common life, in order to remove certain prejudices, which the uſe of general terms, and ways of ſpeaking, with the various aſſociations adhering to them, is apt to introduce and fix upon the mind. It cannot but aſſiſt us in the art of reaſoning, thus to take to pieces, recompoſe and aſcertain our evidences.

If it be aſked, upon what authority abſolute certainty is repreſented by unity, and the ſeveral degrees of probability by fractions leſs than unity, in the doctrine of chances? Alſo, upon what authority the reaſoning uſed in that doctrine is transferred to other ſubjects, and made general, as here propoſed? I anſwer, that no perſon who weighs theſe matters carefully, can avoid giving his aſſent; and that this precludes all objections. No ſceptic would, in fact, be ſo abſurd as to lay 2 to 1, where the doctrine of chances determines the probability to be equal on each ſide; and therefore we may be ſure, that he gives a practical aſſent at leaſt to the doctrine of chances.

Mr. *de Moivre* has ſhewn, that where the cauſes of the happening of an event bear a fixed ratio to thoſe of its failure, the happenings muſt bear nearly the ſame ratio to the failures, if the number of trials be ſufficient; and that the laſt ratio approaches to the firſt indefinitely, as the number of trials increaſes. This may be conſidered as an elegant method of accounting for that order and proportion, which we every where ſee in the phænomena of nature. The determinate ſhapes, ſizes, and mutual actions of the conſtituent particles of matter, fix the ratios between the cauſes for the happenings, and the failures; and therefore it is highly probable, and even neceſſary, as one may ſay, that the happenings and failures ſhould perpetually recur in the ſame ratio to each other nearly, while the circumſtances are the ſame. When the circumſtances are altered, then new cauſes take place; and conſequently there muſt be a new, but fixed ratio, between the happenings and the failures. Let the firſt circumſtances be called *A*, the new ones *B*. If now the ſuppoſition be made ſo general, as equally to take in both *A* and *B*, the ratio of the happenings and failures will not be ſuch as either *A* or *B* required. But ſtill it will tend to a preciſeneſs, juſt as they did, ſince the ſum of the cauſes of the happenings muſt bear a fixed ratio to the ſum of the cauſes of the failures.

An ingenious friend has communicated to me a ſolution of the inverſe problem, in which he has ſhewn what the expectation is, when an event has happened *p* times, and failed *q* times, that the original ratio of the cauſes for the happening or failing of an event ſhould deviate in any given degree from that of *p* to *q*. And it appears from this ſolution, that where the number of trials is very great, the deviation muſt be inconſiderable: which ſhews that we may hope to determine the proportions, and, by degrees, the whole nature, of unknown cauſes, by a ſufficient obſervation of their effects.

The inferences here drawn from theſe two problems are evident to attentive perſons, in a groſs general way, from common methods of reaſoning.

Let us, in the next place, conſider the *Newtonian* differential method, and compare it with that of arguing from experiments and obſervations, by induction and analogy. This differential method teaches, having a certain number of the ordinates of any unknown curve given with the points of the abſciſs on which they ſtand, to find out ſuch a general law for this curve, *i. e.* ſuch an equation expreſſing the relation of an ordinate and abſciſs in all magnitudes of the abſciſs, as will ſuit the ordinates and points of the abſciſs given, in the unknown curve under conſideration. Now here we may ſuppoſe the given ordinates ſtanding upon given points to be analogous to effects, or the reſults of various experiments in given circumſtances, the abſciſs analogous to all poſſible circumſtances, and the equation afforded by the differential method to that law of action, which, being ſuppoſed to take place in the given circumſtances, produces the given effects. And as the uſe of the differential method is to find the lengths of ordinates not given, ſtanding upon points of the abſciſs that are given, by means of the equation, ſo the uſe of attempts to make general concluſions by induction and analogy, from particular effects or phænomena, is to enable us to predict other phænomena in different given circumſtances, by applying the general law or concluſion to theſe circumſtances.

This parallel is the more pertinent and inſtructive, inaſmuch as the mathematical concluſion drawn by the differential method, though formed in a way that is ſtrictly juſt, and ſo as to have the greateſt poſſible probability in its favour, is, however liable to the ſame uncertainties, both in kind and degree, as the general maxims of natural philoſophy drawn from natural hiſtory, experiments, &c.

If many ordinates be given; if the diſtances of the points of the abſciſs, on which they ſtand, be equal and ſmall; if the ordinate required lie amongſt them, or near them; and if there be reaſon to think, that the curve itſelf is formed according to ſome ſimple, though unknown law; then may we conclude, that the new ordinate, determined by the equation, does not vary far from the truth. And if the reſulting equation be ſimple, and always the ſame, from whatever given ordinates it be extracted, there is the greateſt reaſon to think this to be the real original law or equation of the curve; and conſequently that all its points and properties may be determined with perfect exactneſs by means of it: whereas, if the given ordinates be few, their diſtances great or unequal, the ordinate required conſiderably diſtant from many or moſt of them, the unknown curve be a line drawn at hazard, and the reſulting equation very different where different ordinates are given, though their number be the ſame, there will be little probability of determining the new ordinate with exactneſs; however, ſtill the differential method affords us the greateſt probability which the *data* permit in ſuch caſes.

In like manner, if the experiments or obſervations be many, their circumſtances nearly related to each other, and in a regular ſeries, the circumſtances of the effect to be inveſtigated nearly related to them; alſo, if the real cauſe may be ſuppoſed to produce theſe effects, by the varieties of ſome ſimple law, the method of induction and analogy will carry great probability with it. And if the general concluſion or law be ſimple, and always the ſame, from whatever phænomena it be deduced, ſuch as the three laws of nature, the doctrines of gravitation, and of the different refrangibility of light; or, to go ſtill higher, by taking a mathematical inſtance, the law for finding the coefficients of the integral powers of a binomial, deduced from mere trials in various powers; there can ſcarce remain any doubt, but that we are in poſſeſſion of the true law inquired after, ſo as to be able to predict with certainty, in all caſes where we are maſters of the method of computation, or applying it; and have no reaſon to ſuſpect, that other unknown laws interfere. But, if the given phænomena be few, their circumſtances very different from each other, and from thoſe of the effect to be predicted; if there be reaſon to ſuppoſe, that many cauſes concur in the producing theſe phænomena, ſo that the law of their production muſt be very complex; if a new hypotheſis be required to account for every new combination of theſe phænomena; or, at leaſt, one that differs conſiderably from itſelf; the beſt hypotheſis which we can form, *i. e.* the hypotheſis which is moſt conformable to all the phænomena, will amount to no more than an uncertain conjecture; and yet ſtill it ought to be preferred to all others, as being the beſt that we can form.

That inſtantaneous and neceſſary coaleſcence of ideas, which makes intuitive evidence, may be conſidered as the higheſt kind of induction, and as amounting to a perfect coincidence of the effect concluded with thoſe from which it is concluded. This takes place only in mathematics. Thus we infer that 2 and 2 make 4, only from prior inſtances of having actually perceived this, and from the neceſſary coincidence of all theſe inſtances with all other poſſible ones of 2 and 2. Mathematical demonſtrations are made up of a number of theſe, as was obſerved above.

Where the inſtances from whence the induction is made are alike, as far as we know, to that under conſideration, at leaſt in all things that affect the preſent inquiry, it affords the higheſt probability, and may be termed induction, in the proper ſenſe of the word. Thus we infer, that the bread before us is nutritive and wholeſome, becauſe its ſmell, taſte, ingredients, manner of compoſition, &c. are the ſame as thoſe of other bread, which has often before been experienced to be ſo.

But, if the inſtance under conſideration be in ſome reſpects like the foregoing ones, in others not, this kind of proof is generally termed one taken from analogy. Thus, if we argue from the uſe and action of the ſtomach in one animal to thoſe in another, ſuppoſed to be unknown, there will be a probable hazard of being miſtaken, proportional in general to the known difference of the two animals, as well as a probable evidence for the truth of part, at leaſt, of what is advanced, proportional to the general reſemblance of the two animals. But if, upon examination, the ſtomach, way of feeding, &c. of the ſecond animal ſhould be found, to ſenſe, the ſame as in the firſt, the analogy might be conſidered as an induction properly ſo called, at leaſt as approaching to it; for preciſe limits cannot be fixed here. If the ſecond animal be of the ſame ſpecies, alſo of the ſame age, ſex, &c. with the firſt, the induction becomes perpetually of a higher and a higher order, approaching more and more to the coincidence, which obtains in mathematical evidences, and yet never being able entirely to arrive at it. But then the difference, being only an infiniteſimal fraction, as it were, becomes nothing to all practical purpoſes whatſoever. And if a man conſiders farther, that it would be hard to find a demonſtration, that he does not miſtake the plaineſt truths; this leſſens the difference theoretically alſo.

It is often in our power to obtain an analogy where we cannot have an induction; in which caſe reaſoning from analogy ought to be admitted; however, with all that uncertainty which properly belongs to it, conſidered as more or leſs diſtant from induction, as built upon more or fewer dependent or independent evidences, &c. analogy may alſo in all caſes, be made uſe of as a guide to the invention. But coincidence in mathematical matters, and induction in others, wherever they can be had, muſt be ſought for as the only certain teſts of truth. However, induction ſeems to be a very ſufficient evidence in ſome mathematical points, affording at leaſt as much evidence there as in natural philoſophy; and may be ſafely relied on in perplexed caſes, ſuch as complex ſerieſes, till ſatisfactory demonſtrations can be had.

The analogous natures of all the things about us, are a great aſſiſtance in decyphering their properties, powers, laws, &c. inaſmuch as what is minute or obſcure in one may be explained and illuſtrated by the analogous particular in another, where it is large and clear. And thus all things become comments on each other in an endleſs reciprocation.

When there are various arguments for the ſame thing taken from induction or analogy, they may all be conſidered as ſupporting one another in the ſame manner as independent evidences. Thus, if it could be ſhewed, that the human underſtanding is entirely dependent on aſſociation (as is remarked in this and the laſt ſection), the many analogies and connections between the underſtanding and affections, as theſe terms are commonly underſtood and contradiſtinguiſhed by writers, would make it very probable, that aſſociation preſides in the ſame manner in the generation of the affections; and *vice verſa.* And the more analogies, and mutual connections, between the underſtanding and affections, were produced, ſo many more independent or concurrent evidences would there be for this prevalence of aſſociation in one, admitting it in the other. But, if now it be ſhewn farther, that the underſtanding and affections are not really diſtinct things, but only different names, which we give to the ſame kind of motions in the nervous ſyſtem, on account of a difference in degree, and other differences which it would be tedious here to enumerate, but which make no difference in reſpect of the power of aſſociation, then all the arguments from analogy are transformed into one of induction; which, however, is ſtronger than the united force of them all. For now it may be ſhewed, that aſſociation muſt prevail in each motion in the brain, by which affection is expounded, from a large induction of particulars, in which it prevails in the generation of ideas, or of the motions by which they are expounded, and which we ſuppoſe to be proved to be of the ſame kind with thoſe that expound the affections. Thus alſo inductions may be taken from the ſmell and taſte of bread, to prove it wholeſome; which would both be transformed into one ſimple argument ſtronger than both, could we ſee the internal conſtitution of the ſmall parts of the bread, from whence its ſmell, and taſte, and wholeſomeneſs, are all derived. Thus, again, all the arguments of induction for the manner of extracting the ſquare root in numbers vaniſh into the ſingle demonſtrative proof, as ſoon as this is produced. And the great buſineſs in all branches of knowledge is thus to reduce, unite, and ſimplify our evidences; ſo as that the one reſulting proof, by being of a higher order, ſhall be more than equal in force to all the concurrent ones of the inferior orders.

Having now conſidered in what manner the doctrine of chances, and the *Newtonian* differential method, may ſerve to ſhew in general the value of dependent and independent or concurrent evidences, and the probability of general concluſions formed by induction and analogy; let us next inquire by what means we are to form theſe general concluſions, and diſcover their evidences. Now the different methods of doing this may be ſaid to reſemble reſpectively the rule of falſe in common arithmetic; the algebraic methods of bringing the unknown quantity into an equation, under a form capable of all the algebraic operations, addition, ſubtraction, &c. the algebraic methods of finding the roots of equations of the higher orders by approximation; and the art of decyphering: all which four methods bear alſo a conſiderable reſemblance to each other. I will conſider them in order, and endeavour to ſhew how analogous methods may be introduced into the ſciences in general, to advantage.

Firſt, then, As, according to the rule of falſe, the arithmetician ſuppoſes a certain number to be that which is ſought for; treats it as if it was that; and finding the deficiency or overplus in the concluſion, rectifies the error of his firſt poſition by a proportional addition or ſubtraction, and thus ſolves the problem; ſo it is uſeful in inquiries of all kinds, to try all ſuch ſuppoſitions as occur with any appearance of probability, to endeavour to deduce the real phænomena, from them; and if they do not anſwer in ſome tolerable meaſure, to reject them at once; or if they do, to add, expunge, correct, and improve, till we have brought the hypotheſis as near as we can to an agreement with nature, After this it muſt be left to be farther corrected and improved, or entirely diſproved, by the light and evidence reflected upon it from the contiguous, and even, in ſome meaſure, from the remote branches of other ſciences.

Were this method commonly uſed, we might ſoon expect a great advancement in the ſciences. It would much abate that unreaſonable fondneſs, which thoſe who make few or no diſtinct hypotheſes, have for ſuch confuſed ones as occur accidentally to their imaginations, and recur afterwards by aſſociation. For the ideas, words, and reaſonings, belonging to the favourite hypotheſis, by recurring, and being much agitated in the brain, heat it, unite with each other, and ſo coaleſce in the ſame manner, as genuine truths do from induction and analogy. Verbal and grammatical analogies and coincidences are advanced into real ones; and the words which paſs often over the ear, in the form of ſubject and predicate, are from the influence of other aſſociations made to adhere together inſenſibly, like ſubjects and predicates, that have a natural connection. It is in vain to bid an inquirer form no hypotheſis. Every phænomenon will ſuggeſt ſomething of this kind; and, if he does not take care to ſtate ſuch as occur fully and fairly, and adjuſt them one to another, he may entertain a confuſed inconſiſtent mixture of all, of fictitious and real, poſſible and impoſſible; and become ſo perſuaded of it, as that counter aſſociations ſhall not be able to break the unnatural bond. But he that forms hypotheſes from the firſt, and tries them by the facts, ſoon rejects the moſt unlikely ones; and, being freed from theſe, is better qualified for the examination of thoſe that are probable. He will alſo confute his own poſitions ſo often, as to fluctuate in equilibrio, in reſpect of prejudices, and ſo be at perfect liberty to follow the ſtrongeſt evidences.

In like manner, the frequent attempts to make an hypotheſis that ſhall ſuit the phænomena, muſt improve a man in the method of doing this; and beget

get in him by degrees an imperfect practical art, juſt as algebraiſts and decypherers, that are much verſed in practice, are poſſeſſed of innumerable ſubordinate artifices, beſides the principal general ones, that are taught by the eſtabliſhed rules of their arts; and theſe, though of the greateſt uſe to themſelves, can ſcarce be explained or communicated to others. Theſe artifices may properly be referred to the head of factitious ſagacity, being the reſult of experience, and of impreſſions often repeated, with ſmall variations from the general reſemblance.

Laſtly, The frequent making of hypotheſes, and arguing from them ſynthetically, according to the ſeveral variations and combinations of which they are capable, would ſuggeſt numerous phænomena, that otherwiſe eſcape notice, and lead to *experimenta crucis*, not only in reſpect of the hypotheſis under conſideration, but of many others. The variations and combinations juſt mentioned ſuggeſt things to the invention which the imagination unaſſiſted is far unequal to; juſt as it would be impoſſible for a man to write down all the changes upon eight bells, unleſs he had ſome method to direct him.

But this method of making indefinite hypotheſes, and trying them, is far too laborious and mortifying for us to hope, that inquirers will in general purſue it. It would be of great uſe to ſuch as intend to purſue it, to make hypotheſes for the pænomena, whoſe theories are well aſcertained; ſuch as thoſe of the circulation of the blood, of the preſſure of the air, of the different refrangibility of the rays of light, &c. and ſee how they are gradually compelled into the right road, even from wrong ſuppoſitions fairly compared with the phænomena. This would habituate the mind to a right method, and beget the factitious ſagacity above-mentioned.

The ſecond of the four methods propoſed is, that of bringing the unknown quantity to an equation, and putting it into a form ſuſceptible of all the algebraic operations. Now to this anſwers in philoſophy, the art of giving names, expreſſing nothing definite, as to manner, quantity, &c. and then inſerting theſe names, or indefinite terms, in all the enunciations of the phænomena, to ſee whether, from a compariſon of theſe enunciations with each other, where the terms are uſed in the greateſt latitude, ſome reſtrictions, ſomething definite in manner, degree or mutual relation, will not reſult. Things that are quite unknown have often fixed relations to one another, and ſometimes relations to things known, which, though not determinable with certainty and preciſion, may yet be determined in ſome probable manner, or within certain limits. Now, as in algebra it is impoſſible to expreſs the relation of the unknown quantity to other quantities known or unknown, till it has a ſymbol aſſigned to it of the ſame kind with thoſe that denote the others; ſo in philoſophy we muſt give names to unknown quantities, qualities, cauſes, &c. not in order to reſt in them, as the *Ariſtotelians* did, but to have a fixed expreſſion, under which to treaſure up all that can be known of the unknown cauſe, &c. in the imagination and memory, or in writing for future inquirers.

But then it is neceſſary for the ſame reaſons, that theſe terms ſhould have no more of ſecondary ideas from prior aſſociations, than the terms *x* and *y* in algebra. Whence, if we uſe old terms excluding the old aſſociations, the reader ſhould be made aware of this at firſt, and incidentally reminded of it afterwards. Sir *Iſaac Newton* has uſed the words *æther*, *attraction*, and ſome others, in this way, not reſting in them, but enumerating a great variety of phænomena; from the due compariſon of which with each other, and with ſuch as farther obſervation and experiments ſhall ſuggeſt, their laws of action will, perhaps, be diſcovered hereafter; ſo that we may be able to predict the phænomena. There is alſo an inſtance of the proper manner of reaſoning concerning the knowable relations of unknown things in Mr. *Mede's Clavis Apocalyptica.*

The third method is that of approximating to the roots of equations. Here a firſt poſition is obtained, which, though not accurate, approaches, however, to the truth. From this, applied to the equation, a ſecond poſition is deduced, which approaches nearer to the truth than the firſt; from the ſecond, a third, &c. till the analyſt obtains the true root, or ſuch an approximation as is practically equivalent, every preceding diſcovery being made the foundation for a ſubſequent one, and the equation reſolving itſelf, as it were, gradually. Now this is indeed the way, in which all advances in ſcience are carried on; and ſcientific perſons are in general aware, that it is and muſt be ſo. However, I thought it not improper to illuſtrate this general proceſs by a parallel taken from algebra, in which there is great exactneſs and beauty. Beſides, writers do not often diſpoſe their arguments and approximations in this way, though for want of it they loſe much of their clearneſs and force; and, where the writer does this, the reader is frequently apt to overlook the order of proofs and poſitions.

Sir *Iſaac Newton*'s Optics, Chronology, and Comment on *Daniel*, abound with inſtances to this purpoſe; and it is probable, that his great abilities and practice in algebraic inveſtigations led him to it inſenſibly. In his chronology he firſt ſhews in groſs, that the technical chronology of the ancient *Greeks* led them to carry their authorities higher than the truth; and then, that the time of the *Seſoſtris* mentioned by the *Greek* hiſtorians was near that of *Seſac* mentioned in the Old Teſtament; whence it follows, that theſe two perſons were the ſame; and conſequently, that the exact time of *Seſoſtris*'s expedition may now be fixed by the Old Teſtament. And now, having two points abſolutely fixed, viz. the expeditions of *Seſoſtris* and *Xerxes*, he fixes all the moſt remarkable intermediate events; and theſe being alſo fixed, he goes on to the leſs remarkable ones in the *Greek* hiſtory. And the chronology of the *Greeks* being rectified, he makes uſe of it to rectify the cotemporary affairs of the *Egyptians*, *Aſſyrians*, *Babylonians*, *Medes*, and *Perſians*, making uſe of the preceding ſtep every where, for the determination of the ſubſequent one. He does alſo, in many caſes, caſt light and evidence back from the ſubſequent ones upon the precedent. But the other is his own order of proof, and ought to be that in which thoſe who call his chronology in queſtion ſhould proceed to inquire into it.

The fourth and laſt method is that uſed by decypherers, in inveſtigating words written in unknown characters, or in known ones ſubſtituted for one another, according to ſecret and complex laws. The particular methods by which this is done are only known to thoſe who ſtudy and practice this art: however, it is manifeſt in general, that it is an algebra of its own kind; and that it bears a great reſemblance to the three foregoing methods; alſo, that it may be ſaid with juſtneſs and propriety in general, that philoſophy is the art of decyphering the myſteries of nature; that criticiſm bears an obvious relation to decyphering; and that every theory which can explain all the phænomena, has all the ſame evidence in its favour, that it is poſſible the key of a cypher can have from its explaining that cypher. And if the cauſe aſſigned by the theory have alſo its real exiſtence proved, it may be compared to the explanation of a cypher; which may be verified by the evidence of the perſon who writes in that cypher.

Theſe ſpeculations may ſeem uncouth to thoſe who are not converſant in mathematical inquiries; but to me they appear to caſt light and evidence upon the methods of purſuing knowledge in other matters, to ſharpen the natural ſagacity, and to furniſh *Loci* for invention. It appears alſo not impoſſible, that future generations ſhould put all kinds of evidences, and inquiries into mathematical forms; and, as it were, reduce *Ariſtotle*'s ten Categories, and biſhop *Wilkins*'s forty *Summa Genera*, to the head of quantity alone, ſo as to make mathematics and logic, natural hiſtory, and civil hiſtory, natural philoſophy, and philoſophy of all other kinds, coincide *omni ex parte*.

I will add two more remarks relating to the preſent ſubject.

Firſt, then, As in many mechanical problems, which fall ſtrictly under the conſideration of mathematicians, the quantities conſidered depend on ſeveral others, ſo as to increaſe in the ſimple or compound, direct or inverſe ratio of ſeveral others, and not to be greateſt or leaſt, when one or two of theſe are ſo, but when the *factum* of the proper powers of all is ſo; ſo throughout natural philoſophy, in phyſic, in the analyſis of the mind, &c. it is neceſſary to inquire as carefully as we can, upon how many conſiderable cauſes each effect depends; alſo, whether the ratios be ſimple or compound, direct or inverſe. For though it will ſeldom happen, that one can bring the practical problems, that occur in real life, to an exact eſtimate in this way, yet one may avoid part of that uncertainty and confuſion, to which perſons who take things merely in the groſs, are liable. Or in other words, it is better in every thing to have probable or tolerable limits for the *data*, with a regular method of computation, or even an approximation thereto, than to have only ſuch groſs and general conceptions, as reſult from the more or leſs frequent recurrency of impreſſions; even though they be ſomewhat improved by natural or acquired ſagacity, ariſing, in a kind of implicit indefinite way, from experience.

Secondly, It ſeems to me, that the rays of light may be conſidered as a kind of fluxions in reſpect of the biggeſt component particles of matter; I mean thoſe upon which Sir *Iſaac Newton* ſuppoſes the colours of natural bodies, and the changes effected in chemical proceſſes, to depend. For, as the increments of variable quantities, when diminiſhed ſo as to bear no finite ratio to the quantities of which they are the increments, ſhew in a ſimple way the velocities with which theſe quantities are increaſed; and ſo give riſe to the determination of fluxions from fluents, and fluents from fluxions, and to all the applications of theſe determinations to real quantities, all which is entirely grounded upon the ſuppoſition, that the fluxions are not increments, but relative nothings; ſo, ſince the rays of light are ſo ſmall in reſpect of the biggeſt component particles, as to be relatively and practically nothing in reſpect of them, to bear no relation to any of them, all the differences obſervable in the actions of light upon theſe particles, and of theſe particles upon light, will depend purely upon the differences of theſe particles in reſpect of one another; it not being poſſible, that any part of them ſhould ariſe from the comparative magnitude of light, which is equally nothing in reſpect of them all. And thus it ſeems, that optics and chemiſtry will, at laſt, become a maſter-key for unlocking the myſteries in the conſtitution of natural bodies, according to the method recommended by Sir *Iſaac Newton*.

Let *A*, *B*, *C*, be three particles, whoſe magnitudes are 3, 2, and 1, reſpectively. It is evident, that the mutual influences between *A* and *C*, *B* and *C*, cannot correſpond entirely to the ratio which *A* and *B* bear to each other, becauſe *C* bears a different ratio to *A* from that which it bears to *B*; and this difference of ratios muſt have its ſhare in the effects of *A* and *B* upon *C*: whereas had *C* been a particle of light, it would have been equally nothing in reſpect both of *A* and *B*; and ſo the mutual influences between *A* and *C*, *B* and *C*, would entirely correſpond to the difference between *A* and *B*, and decypher it. Thus the particles of light, by being infinitely ſmaller than the biggeſt component ones of natural bodies, may become a kind of *communis norma*, whereby to meaſure their active powers.

PROP. LXXXVIII.

To make a general Application of the Theory of this and the foregoing Section, to the ſeveral Branches of Science.

All the ſciences, knowledge of all kinds, may be reduced to the ſeven general heads following, when they are underſtood in the latitude here expreſſed.

Firſt, Philology, or the knowledge of words, and their ſignifications. It comprehends under it the arts of grammar and criticiſm. Rhetoric and poetry may be referred to it.

Secondly, Mathematics, or the doctrine of quantity. It may be divided into three branches, viz. Arithmetic, which makes uſe of numbers as the exponents of quantity; geometry, which uſes figures for the ſame purpoſe; and algebra, which comprehends both theſe, and whoſe ſymbols are accordingly ſo general, as to repreſent the ſymbols of the two foregoing parts.

Thirdly, Logic, or the art of uſing words, conſidered as ſymbols, for making diſcoveries in all the branches of knowledge. It preſuppoſes philology to a certain degree; and muſt evidently, in the view here given of it, receive great illuſtration from mathematics,

thematics, which is the art of making diſcoveries in the ſingle category of quantity, by means of the ſimpleſt kind of ſymbols.

Fourthly, Natural hiſtory, or regular and well-digeſted accounts of the phænomena of the natural world. It may be diſtributed into ſix parts, *i. e.* into the natural hiſtories of animals, plants, minerals, the earth conſidered as a terraqueous globe, the atmoſphere, and the heavenly bodies.

Fifthly, Civil hiſtory, or regular accounts of the tranſactions of the world politic. To this head muſt be referred that part of geography which treats of the preſent manners, cuſtoms, laws, religion, &c. of the ſeveral nations of the world.

Sixthly, Natural philoſophy, or the application of the arts of mathematics and logic to the phænomena of natural and civil hiſtory, communicated to us by means of our previous ſkill in philology, in order to decypher the laws by which the external world is governed, and thereby to predict or produce ſuch phænomena, as we are intereſted in. Its parts are mechanics, hydroſtatics, pneumatics, optics, aſtronomy, chemiſtry, the theories of the ſeveral manual arts and trades, medicine and pſychology, or the theory of the human mind, with that of the intellectual principles of brute animals.

Seventhly, Religion, which might alſo be called divine philoſophy. This requires the application of all the foregoing branches of knowledge to each other in an endleſs reciprocation, in order to diſcover the nature of the inviſible world, of God, of good and evil ſpirits, and of the future ſtate, which commences at death, with all the duties that reſult from theſe conſiderations. The arts of ethics, and politics are to be referred to this head. For, though theſe arts are ſuppoſed to teach individuals, and bodies politic, how to arrive at their *ſummum bonum* in the preſent world, yet, ſince the rules given for this purpoſe either are or ought to be the ſame with thoſe which teach mankind how to ſecure a happy futurity, it is plain, that theſe arts are included within the precepts of religion.

All theſe branches of knowledge are very much involved in each other; ſo that it is impoſſible to make any conſiderable progreſs in any one, without the aſſiſtance of moſt or all the reſt. However, each has alſo an independent part, which being laid down as a foundation, we may proceed to improve it by the light afforded from the independent parts of the other branches. I will here ſubjoin a few hints concerning the proper manner of proceeding in each branch.

OF PHILOLOGY.

The rudiments of the native language are learnt in infancy, by the repeated impreſſions of the ſounds, at the ſame time that the things ſignified are preſented to the ſenſes, as has been already explained. Words ſtanding for intellectual things, particles, &c. are decyphered by their connection with other words, by their making parts of ſentences, whoſe whole import is known. Grammatical analogy and derivation do alſo, in many caſes, diſcover the import of words. And many words may be explained by definitions. Where theſe ſeveral ways concur, the ſenſe is ſoon learnt, and ſteadily fixed; where they oppoſe each other, confuſion ariſes for a time, but the ſtrongeſt authority prevails at laſt. Tranſlations and dictionaries explain the words of unknown languages by thoſe of known ones. Afterwards we decypher by the context, deduce the ſenſe from analogy, &c. Theſe laſt methods reflect authority upon the tranſlations and dictionaries, where they agree with them. In living languages the import of the principal words may be aſcertained with eaſe and certainty; and theſe being fixed, the reſt become determinable and decypherable by proper care and caution, ſo that no practical errors can remain. In dead languages the difficulty is greater; but the certainty that ultimately reſults, is not leſs practically in reſpect of the bulk of the language, on account of the number of coincidences. But much remains undone yet, particularly in reſpect of the *Hebrew* language. Logic, natural and civil hiſtory, philoſophical and religious knowledge, may all, in their ſeveral ways, contribute to fix the true ſenſe of words. And the fixing the ſenſes of words, by all the methods here enumerated, may be called the art of making dictionaries. It receives great aſſiſtance from the art of grammar; and is at the ſame time the main foundation of it. This laſt art has alſo the ſame connections with the other branches of knowledge; as that of fixing the ſenſes of words. The ſame may be ſaid of criticiſm; which may be defined the art of reſtoring the corrupted paſſages of authors, and aſcertaining their genuine ſenſe, and method of reaſoning.

In all theſe things there ſeems to be a ſufficient foundation for unity of opinion amongſt thoſe that are truly learned and candid; at leaſt in all important points. And, in fact, the differences here amongſt the *literati*, are plainly owing, in great meaſure, to ambition, envy, affectation of ſingularity and novelty, &c. All theſe things magnify the ideas and coaleſcences, which a man calls his own, thoſe of his party, &c. aſſociate ideas of truth, excellence, genius, &c. to them, and oppoſite ones to all that the ſuppoſed adverſary delivers.

No ſceptic can proceed ſo far as to diſclaim the ſenſe of the words of his native tongue, or of a foreign one, which he underſtands. The things ſignified thereby muſt and will be ſuggeſted by, and coaleſce with, the ſounds; ſo that he cannot but underſtand what he hears and reads. And this is all the truth that belongs to philology as ſuch. The truth of the things expreſſed in words is a conſideration belonging to the ſeveral other branches of knowledge reſpectively.

As the plain didactic ſtyle is intended merely to inform the underſtanding, ſo the rhetorical and poetical ſtyles are intended to excite the paſſions by the aſſociations, which figurative terms and forms of expreſſion, flowing periods, numbers, rhymes, ſimiles, fables, fictions, &c. draw after them.

Painting and muſic produce a like effect upon the paſſions as rhetoric and poetry, and by means that are not very unlike. But I ſhall have occaſion hereafter to ſay ſomething more concerning all theſe imaginative arts.

OF MATHEMATICS.

Mathematics are that branch of knowledge which is the moſt independent of any, and the leaſt liable to uncertainty, difference of opinion, and ſceptical doubts. However, uncertainties, differences, and doubts, have ariſen here; but then they have been chiefly about ſuch parts of mathematics as fall under the conſideration of the logician. For, it ſeems impoſſible that a man who has qualified himſelf duly, ſhould doubt about the juſtneſs of an arithmetical, algebraical, or fluxional operation, or the concluſiveneſs of a geometrical demonſtration.

The words point, line, ſurface, infinitely great, infinitely little, are all capable of definitions, at leaſt of being explained by other words. But then theſe words cannot ſuggeſt any viſible ideas to the imagination, but what are inconſiſtent with the very words themſelves. However, this inconſiſtency has no effect upon the reaſoning. It is evident, that all that can be meant by the three angles of a triangle being equal to two right ones, or the parabolic area to $\frac{2}{3}$ of the circumſcribing parallelogram, or deduced from theſe poſitions, muſt always hold in future fact; and this, as obſerved above, is all the truth that any thing can have. In fluxional concluſions it is demonſtratively evident, that the quantity under conſideration cannot be greater or leſs by any thing aſſignable, than according to the fluxional concluſion; and this ſeems to me entirely the ſame thing as proving it to be equal.

I cannot preſume to ſuggeſt any particular methods by which farther diſcoveries may be made in mathematical matters, which are ſo far advanced, that few perſons are able to comprehend even what is diſcovered and unfolded already. However, it may not be amiſs to obſerve, that all the operations of arithmetic, geometry, and algebra, ſhould be applied to each other in every poſſible way, ſo as to find out in each ſomething analogous to what is already known and eſtabliſhed in the other two. The application of the arithmetical operations of diviſion and extraction of roots to algebraic quantities, and of the method of obtaining the roots of numeral equations by approximation to ſpecious ones, as taught by Sir *Iſaac Newton*, have been the ſources of the greateſt fluxional diſcoveries.

OF LOGIC.

It is the purport of this and the foregoing ſection, to give imperfect rudiments of ſuch an art of logic, as is defined above, *i. e.* as ſhould make uſe of words in the way of mathematical ſymbols, and proceed by mathematical methods of inveſtigation and computation in inquiries of all ſorts. Not that the *data* in the ſciences are as yet, in general, ripe for ſuch methods; but they ſeem to tend to this more and more perpetually, in particular branches, ſo that it cannot be amiſs to prepare ourſelves, in ſome meaſure, previouſly.

Logic, and metaphyſics, which are nearly allied to logic, ſeem more involved in obſcurity and perplexity, than any other part of ſcience. This has probably been the chief ſource of ſcepticiſm, ſince it appears neceſſary, that that part of knowledge, which is the baſis of all others, which is to ſhew wherein certainty, probability, poſſibility, improbability, and impoſſibility, conſiſt, ſhould itſelf be free from all doubt and uncertainty.

It ſeems alſo, that as logic is required for the baſis of the other ſciences, ſo a logic of a ſecond order is required for a baſis to that of the firſt, of a third for that of the ſecond, and ſo on *ſine limite*: which, if it were true, would, from the nature of dependent evidences, prove that logic is either abſolutely certain, or abſolutely void of all probability. For, if the evidence for it be ever ſo little inferior to unity, it will, by the continual infinite multiplication required in dependent evidences infinitely continued, bring itſelf down to nothing. Therefore, *e converſo*, ſince no one can ſay, that the rules of logic are void of all probability, the *ſummum genus* of them muſt be certain. This *ſummum genus* is the neceſſary coaleſcence of the ſubject with the predicate. But the argument here alleged is merely one *ad hominem*, and not the natural way of treating the ſubject. The neceſſary coaleſcence juſt ſpoken of carries its own evidence with it. It is neceſſary from the nature of the brain, and that in the moſt confirmed ſceptic, as well as in any other perſon. And we need only inquire into the hiſtory of the brain, and the phyſiological influences of words and ſymbols upon it by aſſociation, in order to ſee this. I am alſo inclined to believe, that the method here propoſed of conſidering words and ſentences as impreſſions, whoſe influence upon the mind is entirely to be determined by the aſſociations heaped upon them in the intercourſes of life, and endeavouring to determine theſe aſſociations, both analytically and ſynthetically, will caſt much light upon logical ſubjects, and cut off the ſources of many doubts and differences.

As the theories of all other arts and ſciences muſt be extracted from them, ſo logic, which contains the theory of all theſe theories, muſt be extracted from theſe theories; and yet this is not to reaſon in a circle in either caſe, ſince the theory is firſt extracted from ſelf-evident or allowed particulars, and then applied to particulars not yet known, in order to diſcover and prove them.

It may not be amiſs here to take notice how far the theory of theſe papers has led me to differ, in reſpect of logic, from Mr. *Locke*'s excellent *Eſſay on Human Underſtanding*, to which the world are ſo much indebted for removing prejudices and incumbrances, and advancing real and uſeful knowledge.

Firſt, then, It appears to me, that all the moſt complex ideas ariſe from ſenſation; and that reflection is not a diſtinct ſource, as Mr. *Locke* makes it.

Secondly, Mr. *Locke* aſcribes ideas to many words, which, as I have defined idea, cannot be ſaid to have any immediate and preciſe ones; but only to admit of definitions. However, let definition be ſubſtituted inſtead of idea, in theſe caſes, and then all Mr. *Locke*'s excellent rules concerning words, delivered in his third book, will ſuit the theory of theſe papers.

As to the firſt difference, which I think may be called an error in Mr. *Locke*, it is, however, of little conſequence. We may conceive, that he called ſuch ideas as he could analyſe up to ſenſation, ideas of ſenſation; the reſt ideas of reflection, uſing reflection as a term of art, denoting an unknown quantity. Beſides which it may be remarked, that the words which, according to him, ſtand for ideas of reflection, are, in general, words, that, according to the theory of theſe papers, have no ideas, but definitions only. And thus the firſt difference, is as it were, taken away by the ſecond; for, if theſe words have no immediate ideas, there will be no occaſion to have recourſe to reflection as a ſource of ideas; and, upon the whole, there is no material repugnancy between the conſequences of this theory, and any thing advanced by Mr. *Locke*.

The ingenious biſhop *Berkeley* has juſtly obſerved againſt Mr. *Locke*, that there can be no ſuch thing as abſtract ideas, in the proper ſenſe of the word idea. However, this does not ſeem to vitiate any conſiderable part of Mr. *Locke*'s reaſoning. Subſtitute definition for idea in the proper places, and his concluſions will hold good in general.

OF NATURAL HISTORY.

Natural hiſtory is a branch of knowledge, which, at the firſt view, appears to have a boundleſs extent, and to be capable of the utmoſt practical preciſion and certainty, if ſufficient care and induſtry be employed. And, in fact, the doubts and differences here are not very conſiderable; they do alſo grow leſs and leſs every day, by the great quantity of knowledge of this kind, which is poured in from all quarters, as learning and inquiſitiveneſs diffuſe themſelves more and more amongſt all nations, and all orders of men.

The materials for natural hiſtory, which any ſingle perſon can collect from his own obſervation, being very inconſiderable, in reſpect of thoſe which he wants, he is obliged to have recourſe to others; and therefore muſt depend upon their teſtimony, juſt as in civil hiſtory. And our aſſent in each caſe, being excited by a variety of concurrent proofs, and of coincident circumſtances, transfers part of its authority upon the other. We believe teſtimony in natural hiſtory, becauſe

cauſe do we in civil, and *vice verſa*; and have a variety of concurrent confirmations in both caſes.

However, as the general facts are thus practically certain, ſo the ſubordinate ones are, in many caſes, liable to doubts. And it is evident, that for the reſolution of theſe doubts in natural hiſtory, we muſt borrow the aſſiſtance of all the other branches of ſcience; and that ſome ſkill in philology muſt be attained, before we can hope to arrive at any tolerable perfection in natural or civil hiſtory. Natural hiſtory is the only ſure baſis of natural philoſophy, and has ſome influence upon all the other ſciences.

OF CIVIL HISTORY.

The general evidences upon which civil hiſtory is grounded, have been juſt hinted at. It is manifeſt, that the diſcoveries of natural hiſtorians, aſtronomers, linguiſts, antiquaries, and philoſophers of all kinds, have brought great light and evidence upon this branch of knowledge within the laſt two centuries; and are likely to do ſo more and more.

The ancient hiſtory of the kingdoms of *Aſia Minor*, *Egypt*, and *Greece*, will probably be much better underſtood, when the inhabitants of thoſe countries become learned.

He that would ſearch into the firſt ages of the world, muſt take the ſcriptures for his guide, lay down the truth of theſe as unqueſtionable, and force all other evidences into that poſition. This ſeems to have been the method taken by Sir *Iſaac Newton* in his Chronology, and which at laſt unfolded to him the proper method of detecting and correcting the miſtakes in the ancient technical chronology of the *Greeks* by itſelf.

The concurrent independent evidences in the grand points of hiſtory are ſo much more numerous than the dependent ones, and moſt of them ſo ſtrong, ſingly taken, that the deficiency from certainty in theſe grand points cannot be diſtinguiſhed by the human mind. And therefore it is a practical error of great importance to ſuppoſe, that ſuch kind of hiſtorical evidences are inferior to mathematical ones. They are equal, as far as we have any thing to do with them, *i. e.* can judge of them, or be influenced by them. All future facts depending on them have as good a baſis, as thoſe depending on mathematical evidences. I ſpeak here of principal matters, ſuch as the conqueſts of *Alexander* and *Julius Cæſar*, and the main hiſtory, common and miraculous, of the Old and New Teſtaments. Till our knowledge be applied to the predicting or producing future facts, no ſort of it is of uſe or importance to us; and the application of mathematical knowledge is juſt as much expoſed to the ſeveral kinds and degrees of uncertainty, as that of any other. That the evidence for principal hiſtorical facts is not, in general, conſidered as equal to mathematical certainty, ariſes partly from the juſt-mentioned ill-grounded affirmations of learned men; partly from the complexneſs of the hiſtorical proofs, which require time and conſideration to digeſt them; and partly becauſe the uncertainty attending ſubordinate facts has diluted the evidence of the principal and unqueſtionable ones, ſince the ſame general forms of expreſſion are, and muſt be, uſed in both caſes.

OF NATURAL PHILOSOPHY.

It may be obſerved of natural philoſophy, that in the parts where the ideas are ſimple, clear, and of the viſible kind, or adequately expounded by ſuch, and the method of inveſtigation and computation mathematical, as in mechanics, hydroſtatics, pneumatics, optics, and aſtronomy, the doubts and diverſities of opinion which ariſe, are inconſiderable. But in the theories of chemiſtry, of manual arts and trades, of medicine, and, in general, of the powers and mutual actions of the ſmall parts of matter, the uncertainties and perplexities are as great, as in any part of ſcience. For the ſmall parts of matter, with their actions, are too minute to be the objects of ſight; and we are as yet neither poſſeſſed of a detail of the phænomena ſufficiently copious and regular, whereon to ground an inveſtigation; nor of a method of inveſtigation ſubtle enough to arrive at the ſubtlety of nature, even in the biggeſt component particles, much leſs in the particles of the ſmaller orders; and how far the number of orders may go, is impoſſible to ſay. I ſee no contradiction in ſuppoſing it infinite, and a great difficulty in ſtopping at any particular ſize.

Suppoſe the number of orders of particles infinite, or at leaſt very great; and that particles of all orders are perpetually flying off from all bodies with great velocity. Firſt, This may occaſion the gravitation of the great bodies of the univerſe to each other, by the impulſe of the ſmaller corpuſcles upon particles of ſizes equal to each other in the greater bodies, the impulſes of the larger corpuſcles, and upon particles, of unequal ſize, being evaneſcent in reſpect of the foregoing impulſes. But where particles approach near to one another, and the corpuſcles bear ſome finite ratio to the particles, ſo as not to pervade them freely, before they come to particles of equal ſize to each other, but affect them in proportion to their ſurfaces, not ſolid content, and I ſuppoſe from many other cauſes, attractions of other kinds may ariſe: and if one or both of the contiguous particles ſend out many corpuſcles with great force; alſo, if theſe corpuſcles efferveſce together in the intermediate ſpace, and gain new forces thence, &c. repulſive powers may riſe. If it be reaſonable to ſuppoſe many orders of particles, it is alſo reaſonable to ſuppoſe, that their powers and properties are ſomewhat analogous to one another; and that thoſe of the larger particles ariſe from, and are compounded of, thoſe of the next leſs in ſize, and ſo on; juſt as the whole gravity of the moon is compounded of the gravity of all its parts. But theſe are all very groſs and uncertain conjectures.

In the mean time, it ſeems proper to uſe the words magnetiſm, electricity, attraction of coheſion, *ſpiritus rector*, acrimony of the animal juices, &c. as terms of art, as unknown cauſes of known effects. But then they ought always to be defined, the definitions rigorouſly kept to, and all ſecondary ideas from prior aſſociations excluded. Were this done in chemiſtry and medicine, it would produce a great reformation, and at once cut off many incumbrances, perplexities and obſcurities. The *vis inertiæ* of bodies, and the equivalent terms, were once terms of this kind, ſtanding for the unknown cauſe of known phænomena. By degrees theſe phænomena were digeſted into order, the terms contributing thereto, and the three ſeveral kinds of them, claſſed reſpectively under the three laws of nature, which have been applied ſynthetically ſince, and given riſe to the greateſt mechanical diſcoveries. The ſame may be obſerved of gravity. And if the laws of magnetiſm, electricity, and the attraction of coheſion, could be aſcertained in the ſame manner as the laws of the *vis inertiæ* and gravity, we ſhould be enabled to predict and produce many effects of great importance to us.

It is of the higheſt uſe to us in practical matters, that the properties of bodies are ſo cloſely connected with each other. Thus the colour and ſpecific gravity of a metal, the viſible idea of a plant, alſo its taſte or ſmell, give us a practical certainty in reſpect of all the other properties. This cloſe connection of the properties follows undoubtedly from the powers and mutual actions of the ſmall parts; ſo that, if we could arrive at the knowledge of theſe laſt, we ſhould immediately ſee not only the reaſon of all the properties of bodies, which are known at preſent, but be able to diſcover innumerable other relative ones. In the mean time we muſt endeavour to diſcover, digeſt, and regiſter, the various properties of natural bodies, as they riſe to view from ſuitable experiments; and thus prepare the way for thoſe who ſhall hereafter decypher their internal conſtitution.

OF RELIGION.

All the foregoing branches of knowledge ought to be conſidered as mere preparatories and preliminaries to the knowledge of religion, natural and revealed. They all, in their ſeveral orders and degrees, concur to eſtabliſh the principal doctrines and duties of it; and theſe, when eſtabliſhed, become the beſt means for attaining knowledge. The benevolence of the Deity, and the doctrine of final cauſes, are the beſt clue for guiding us through the labyrinths of natural phænomena, and particularly of thoſe which relate to animals. The ſcriptures are the only book which can give us any juſt idea of ancient times, of the original of mankind, their diſperſion, &c. or of what will befal them in future generations. As to future things, predicted in the ſcriptures, we can as yet collect nothing more than general intimations; but there is reaſon to believe, that ſucceeding generations may arrive at a far more preciſe interpretation of prophecy. It may alſo be, that much philoſophical knowledge is concealed in the ſcriptures; and that it will be revealed in its due time. The analogy between the word and works of God, which is a conſideration of the religious kind, ſeems to comprehend the moſt important truths. To all this it muſt be added, that the temper of mind preſcribed by religion, viz. modeſty, impartiality, ſobriety, and diligence, are the beſt qualifications for ſucceeding in all inquiries. Thus religion comprehends, as it were, all other knowledge, advances, and is advanced by all; at the ſame time that where there is a morally good diſpoſition, a very ſmall portion of other knowledge is ſufficient for the attainment of all that is neceſſary for virtue and comfort here, and eternal happineſs hereafter.

The great differences of opinion, and contentions which happen in religious matters, are plainly owing to the violence of men's paſſions, more than to any other cauſe. Where religion has its due effect in reſtraining theſe, and begetting true candour, we may expect a unity of opinion, both in religious and other matters, as far as is neceſſary for uſeful practical purpoſes.

SECT. III.

OF THE AFFECTIONS IN GENERAL.

PROP. LXXXIX.

To explain the Origin and Nature of the Paſſions in general.

Here we may obſerve,

Firſt, That our paſſions or affections can be no more than aggregates of ſimple ideas united by aſſociation. For they are excited by objects, and by the incidents of life. But theſe, if we except the impreſſed ſenſations, can have no power of affecting us, but what they derive from aſſociation; juſt as was obſerved above of words and ſentences.

Secondly, Since therefore the paſſions are ſtates of conſiderable pleaſure or pain, they muſt be aggregates of the ideas, or traces of the ſenſible pleaſures and pains, which ideas make up by their number, and mutual influence upon one another, for the faintneſs and tranſitory nature of each ſingly taken. This may be called a proof *a priori.* The proof *a poſteriori* will be given, when I come to analyſe the ſix claſſes of intellectual affections, viz. imagination, ambition, ſelf-intereſt, ſympathy, theopathy, and the moral ſenſe.

Thirdly, As ſenſation is the common foundation of all theſe, ſo each in its turn, when ſufficiently generated, contributes to generate and model all the reſt. We may conceive this to be done in the following manner. Let ſenſation generate imagination; then will ſenſation and imagination together generate ambition; ſenſation, imagination, and ambition, ſelf-intereſt; ſenſation, imagination, ambition, and ſelf-intereſt, ſympathy; ſenſation, imagination, ambition, ſelf-intereſt, and ſympathy, theopathy; ſenſation, imagination, ambition, ſelf-intereſt, ſympathy, and theopathy, the moral ſenſe: and, in an inverted order, imagination will new-model ſenſation; ambition, ſenſation and imagination; ſelf-intereſt, ſenſation, imagination, and ambition; ſympathy, ſenſation, imagination, ambition, and ſelf-intereſt; theopathy, ſenſation, imagination, ambition, ſelf-intereſt, and ſympathy; and the moral ſenſe, ſenſation, imagination, ambition, ſelf-intereſt, ſympathy, and theopathy: till at laſt, by the numerous reciprocal influences of all theſe upon each other, the paſſions arrive at that degree of complexneſs, which is obſerved in fact, and which makes them ſo difficult to be analyſed.

Fourthly, As all the paſſions ariſe thus from pleaſure and pain, their firſt and moſt general diſtribution may be into the two claſſes of love and hatred, *i. e.* we may term all thoſe affections of the pleaſurable kind, which objects and incidents raiſe in us, love; all thoſe of the painful kind, hatred. Thus we are ſaid to love not only intelligent agents of morally good diſpoſitions, but alſo ſenſual pleaſures, riches, and honours; and to hate poverty, diſgrace, and pain, bodily and mental.

Fifthly, When our love and hatred are excited to a certain degree, they put us upon a variety of actions, and may be termed deſire and averſion; by which laſt word I underſtand an active hatred. Now the actions which flow from deſire and averſion, are entirely the reſult of aſſociated powers and circumſtances, agreeably to the twentieth, twenty-firſt, and twenty-ſecond propoſitions, with their corollaries, The young child learns to graſp, and go up to the play-thing that pleaſes him, and to withdraw his hand from the fire that burns him, at firſt from the mechaniſm of his nature, and without any deliberate purpoſe of obtaining pleaſure, and avoiding pain, or any explicit reaſoning about them. By degrees he learns, partly from the recurrency of theſe mechanical tendencies, inſpired by God, as one may ſay, by means of the nature which he has given us; and partly from the inſtruction and imitation of others; to purſue every thing which he loves and deſires; fly from every thing which he hates; and to reaſon about the method of doing this, juſt as he does upon other matters. And, becauſe mankind are for the moſt part purſuing or avoiding ſomething or other, the deſire of happineſs, and the averſion to miſery, are ſuppoſed to be inſeparable from, and eſſential to, all intelligent natures. But this does not ſeem to be an exact or correct way of ſpeaking. The moſt general of our deſires and averſions are factitious, *i. e.* generated by aſſociation; and therefore admit of intervals, augmentations, and diminutions. And, whoever will be ſufficiently attentive to the workings of his own mind, and the actions reſulting therefrom, or to the actions of others, and the affections which may be ſuppoſed to occaſion them, will find ſuch differences and ſingularities in different perſons, and in the ſame perſon at different times, as no way agree to the notion of an eſſential, original, perpetual deſire of happineſs, and endeavour to attain it; but much rather to the factitious aſſociated deſires and endeavours here aſſerted. And a due regard to this will, as it ſeems to me, ſolve many difficulties and perplexities found in treatiſes upon the paſſions. The writers upon this ſubject have begun in the ſynthetical method prematurely, and without having premiſed the analytical one. For it is very true, that, after general deſires and endeavours are generated, they give riſe in their turn to a variety of particular ones. But the original ſource is in the particular ones, and the general ones never alter and new-model the particular ones ſo much, as that there are not many traces and veſtiges of their original mechanical nature and proportions remaining.

Sixthly, The will appears to be nothing but a deſire or averſion ſufficiently ſtrong to produce an action that is not automatic primarily or ſecondarily. At leaſt it appears to me, that the ſubſtitution of theſe words for the word *will* may be juſtified by the common uſage of language. The will is therefore that deſire or averſion, which is ſtrongeſt for the then preſent time. For if any other deſire was ſtronger, the muſcular motion connected with it by aſſociation would take place, and not that which proceeds from the will, or the voluntary one, which is contrary to the ſuppoſition. Since therefore all love and hatred, all deſire and averſion, are factitious, and generated by aſſociation, *i. e.* mechanically; it follows that the will is mechanical alſo.

Seventhly, Since the things which we purſue do, when obtained, generally afford pleaſure, and thoſe which we fly from affect us with pain, if they overtake us, it follows that the gratification of the will is generally attended or aſſociated with pleaſure, the diſappointment of it with pain. Hence a mere aſſociated pleaſure is transferred upon the gratification of the will; a mere aſſociated pain upon the diſappointment of it. And if the will was always gratified, this mere aſſociated pleaſure would, according to the preſent frame of our natures, abſorb, as it were, all our other pleaſures; and thus by drying up the ſource from whence it ſprung, be itſelf dried up at laſt: and the firſt diſappointments, after a long courſe of gratification, would be intolerable. Both which things are ſufficiently obſervable, in an inferior degree, in children that are much indulged, and in adults, after a ſeries of ſucceſsful events. Gratifications of the will without the conſequent expected pleaſure, and diſappointments of it without the conſequent expected pain, are particularly uſeful to us here. And it is by this, amongſt other means, that the human will is brought to a conformity with the divine; which is the only radical cure for all our evils and diſappointments, and the only earneſt and medium for obtaining laſting happineſs.

Eighthly, We often deſire and purſue things which give pain rather than pleaſure. Here it is to be ſuppoſed, that at firſt they afforded pleaſure, and that they now give pain on account of a change in our nature and circumſtances. Now, as the continuance to deſire and purſue ſuch objects, notwithſtanding the pain ariſing from them, is the effect of the power of aſſociation, ſo the ſame power will at laſt reverſe its own ſteps, and free us from ſuch hurtful deſires and purſuits. The recurrency of pain will at laſt render the object undeſirable and hateful. And the experience of this painful proceſs, in a few particular inſtances, will at laſt, as in other caſes of the ſame kind, beget a habit of ceaſing to purſue things, which we perceive by a few trials, or by rational arguments, to be hurtful to us upon the whole.

Ninthly, A ſtate of deſire ought to be pleaſant at firſt from the near relation of deſire to love, and of love to pleaſure and happineſs. But in the courſe of a long purſuit, ſo many fears and diſappointments, apparent or real, in reſpect of the ſubordinate means, and ſo many ſtrong agitations of mind paſſing the limits of pleaſure, intervene, as greatly to chequer a ſtate of deſire with miſery. For the ſame reaſons ſtates of averſion are chequered with hope and comfort.

Tenthly, Hope and fear are, as juſt now obſerved, the attendants upon deſire and averſion. Theſe affect us more or leſs, according to the more or leſs frequent recurrency of the pleaſing and painful ideas, according to the greater or leſs probability of the expected event, according to the greater or leſs diſtance of time, &c. the power of aſſociation diſplaying itſelf every where in the agitations of mind excited by theſe paſſions. It is particularly remarkable here that our hopes and fears riſe and fall with certain bodily diſpoſitions, according as theſe favour or oppoſe them.

Eleventhly, Joy and grief take place when the deſire and averſion, hope and fear, are at an end; and are love and hatred, exerted towards an object which is preſent, either in a ſenſible manner, or in a rational one, *i. e.* ſo as to occupy the whole powers of the mind, as ſenſible objects, when preſent, and attended to, do the external ſenſes. It is very evident, that the objects of the intellectual pleaſures and pains derive their power of thus affecting the mind from aſſociation.

Twelfthly, After the actual joy and grief are over, and the object withdrawn, there generally remains a pleaſing or diſpleaſing recollection or reſentment, which recurs with every recurrency of the idea of the object, or of the aſſociated ones. This recollection keeps up the love or hatred. In like manner the five grateful paſſions, love, deſire, hope, joy, and pleaſing recollection, all enhance one another; as do the five ungrateful ones, hatred, averſion, fear, grief, and diſpleaſing recollection. And the whole ten, then together, comprehend, as appears to me, all the general paſſions of human nature.

SECT. IV.

OF MEMORY.

PROP. XC.

To examine how far the Phænomena of Memory are agreeable to the foregoing Theory.

MEMORY was defined in the introduction to be that faculty by which traces of ſenſations and ideas recur, or are recalled, in the ſame order and proportion, accurately or nearly, as they were once preſented.

Now here we may obſerve,

Firſt, That memory depends entirely or chiefly on the ſtate of the brain. For diſeaſes, concuſſions of the brain, ſpirituous liquors, and ſome poiſons, impair or deſtroy it; and it generally returns again with the return of health, from the uſe of proper medicines and methods. And all this is peculiarly ſuitable to the notion of vibrations. If ſenſations and ideas ariſe from peculiar vibrations, and diſpoſitions to vibrate, in the medullary ſubſtance of the brain, it is eaſy to conceive, that the cauſes above alleged may ſo confound the ſenſations and ideas, as that the uſual order and proportion of the ideas ſhall be deſtroyed.

Secondly, The rudiments of memory are laid in the perpetual recurrency of the ſame impreſſions, and cluſters of impreſſions. How theſe leave traces, in which the order is preſerved, may be underſtood from the eighth, ninth, tenth, and eleventh propoſitions. The traces which letters, and words, *i. e.* cluſters of letters, leave, afford an inſtance and example of this. And, as in languages the letters are fewer than the ſyllables, the ſyllables than the words, and the words than the ſentences, ſo the ſingle ſenſible impreſſions, and the ſmall cluſters of them, are comparatively few in reſpect of the large cluſters; and, being ſo, they muſt recur more frequently, ſo as the ſooner to beget thoſe traces which I call the rudiments or elements of memory. When theſe traces or ideas begin to recur frequently, this alſo contributes to fix them, and their order, in the memory, in the ſame manner as the frequent impreſſion of the objects themſelves.

Thirdly, Suppoſe now a perſon ſo far advanced in life, as that he has learnt all theſe rudiments, *i. e.* that he has ideas of the common appearances and occurrences of life, under a conſiderable variety of ſubordinate circumſtances, which recur to his imagination from the ſlighteſt cauſes, and with the moſt perfect facility; and let us aſk, how he can be able to remember, or recollect a paſt fact, conſiſting of one thouſand ſingle particulars, or of one hundred ſuch cluſters as are called the rudiments of memory; ten ſingle particulars being ſuppoſed to conſtitute a rudiment? Firſt, then, we may obſerve, that there are only one hundred links wanting in the chain; for he has already learnt conſiderable exactneſs in the ſubordinate circumſtances of the one hundred cluſters; and perfect exactneſs is not to be ſuppoſed or required.—Secondly, The one hundred cluſters recur again and again to the imagination for ſome time after the fact, in a quick and tranſient manner, as thoſe who attend ſufficiently to what paſſes in their own minds may perceive; and this both makes the impreſſion a little deeper, and alſo ſerves to preſerve the order. If the perſon attempts to recollect ſoon after the impreſſion, the effect remaining in the brain is ſufficient to enable him to do this with the accuracy required and experienced; if a longer time intervenes, before he attempts to recollect, ſtill the number of involuntary recurrencies makes up in ſome meaſure for the want of this voluntary recollection. However, the power of recollection declines in general, and is

entirely

entirely loſt by degrees. It confirms this reaſoning, that a new ſet of ſtrong impreſſions deſtroys this power of recollection. For this muſt both obliterate the effects of the foregoing impreſſions, and prevent the recurrency of the ideas.—Thirdly, As the ſingle impreſſions, which make the ſmall cluſters, are not combined together at hazard, but according to a general tenor in nature, ſo the cluſters which make facts ſucceed each other according to ſome general tenor likewiſe. Now this both leſſens the number of varieties, and ſhews that the aſſociation between many of the cluſters, or rudiments, or one hundred links ſuppoſed to be wanting, is cemented already. This may be both illuſtrated and exemplified by the obſervation, that it is difficult to remember even well-known words that have no connection with each other, and more ſo to remember collections of barbarous terms; whereas adepts in any ſcience remember the things of that ſcience with a ſurprizing exactneſs and facility.—Fourthly, Some cluſters are excluded from ſucceeding others, by ideas of inconſiſtency, impoſſibility, and by the methods of reaſoning, of which we become maſters as we advance in life.—Fifthly, The viſible impreſſions which concur in the paſt fact, by being vivid, and preſerving the order of place, often contribute greatly to preſerve the order of time, and to ſuggeſt the cluſters which may be wanting.—Sixthly, It is to be obſerved, that as we think in words both the impreſſions and the recurrencies of ideas will be attended with words; and theſe words, from the great uſe and familiarity of language, will fix themſelves ſtrongly in the fancy, and by ſo doing bring up the aſſociated trains of ideas in the proper order, accurately or nearly. And thus, when a perſon relates a paſt fact, the ideas do in ſome caſes ſuggeſt the words, whilſt in others the words ſuggeſt the ideas. Hence illiterate perſons do not remember nearly ſo well as others, *cæteris paribus*. And

I ſuppoſe the ſame is true of deaf perſons in a ſtill greater degree. But it ariſes hence alſo, that many miſtakes in the ſubordinate circumſtances are committed in the relations of paſt facts, if the relater deſcends to minute particulars. For the ſame reaſons theſe miſtakes will be ſo aſſociated with the true facts after a few relations, that the relater himſelf ſhall believe, that he remembers them diſtinctly.—Seventhly, The miſtakes which are committed both on the foregoing account and others, make conſiderable abatements in the difficulty here to be ſolved.

Fourthly, Let it now be aſked, in what the recollection of a paſt fact, conſiſting of one hundred cluſters, as above, differs from the tranſit of the ſame one hundred cluſters over the fancy, in the way of a reverie? I anſwer, partly in the vividneſs of the cluſters, partly and principally in the readineſs and ſtrength of the aſſociations, by which they are cemented together. This follows from what has been already delivered; but it may be confirmed alſo by many other obſervations.—Thus, firſt many perſons are known by relating the ſame falſe ſtory over and over again, *i. e.* by magnifying the ideas, and their aſſociations, at laſt to believe that they remember it. It makes as vivid an impreſſion upon them, and hangs as cloſely together, as an aſſemblage of paſt facts recollected by memory.—Secondly, All men are ſometimes at a loſs to know whether cluſters of ideas that ſtrike the fancy ſtrongly, and ſucceed each other readily and immediately, be recollections, or mere reveries. And the more they agitate the matter in the mind, the more does the reverie appear like a recollection. It reſembles this, that if in endeavouring to recollect a verſe, a wrong word, ſuiting the place, firſt occurs, and afterwards the right one, it is difficult during the then preſent agitation to diſtinguiſh the right one. But afterwards, when this agitation is ſubſided, the right word eaſily regains its place. Perſons of irritable nervous ſyſtems are more ſubject to ſuch fallacies than others. And madmen often impoſe upon themſelves in this way, viz. from the vividneſs of their ideas and aſſociations, produced by bodily cauſes. The ſame thing often happens in dreams. The vividneſs of the new ſcene often makes it appear like one that we remember, and are well acquainted with. Thirdly if the ſpecific nature of memory conſiſt in the great vigour of the ideas, and their aſſociations, then, as this vigour abates, it ought to ſuggeſt to us a length of time elapſed; and *vice verſa*, if it be kept up, the diſtance of time ought to appear contracted. Now this laſt is the caſe: for the death of a friend, or any intereſting event, often recollected and related, appears to have happened but yeſterday, as we term it, viz. on account of the vividneſs of the cluſters, and their aſſociations, correſponding to the nature of a recent event.—Fourthly, It is not, however, to be here ſuppoſed, that we have not many other ways of diſtinguiſhing real recollections from mere reveries. For the firſt are ſupported by their connection with known and allowed facts, by various methods of reaſoning, and having been related as real recollections, &c.

Fifthly, In like manner we diſtinguiſh a new place, book, perſon, &c. from one which we remember, ſuppoſing both to be preſented in like circumſtances. The parts, aſſociates, &c. of that which we remember, ſtrike us more ſtrongly, are ſuggeſted by each other, and hang together, which does not hold of the new. The old does alſo ſuggeſt many aſſociates, which a new one in like circumſtances would not. And if from the then ſtate of fancy, the diſtance of time, &c. there be any doubt of theſe things, either with reſpect to the old or new, a like doubt ariſes in reſpect of the memory. An attentive perſon may obſerve, that he determines of ſuch things, whether they be old or new, by the vividneſs of the ideas, and their power of ſuggeſting each other, and foreign aſſociates.

Some perſons ſeem to ſuppoſe, that the ſoul ſurveys one object, the old for inſtance, and comparing it with the impreſſions which a ſimilar new one would excite, calls the old one an object remembered. But this is like ſuppoſing an eye within the eye to view the pictures made by objects upon the *retina*. Not to mention, that the ſoul cannot in the ſame inſtant, during the ſame τὸ νῦν, ſurvey both the old and new, and compare them together; nor is there any evidence, that this is done in fact. A perſon who inquires into the nature of memory, may indeed endeavour to ſtate the difference between the impreſſions of old and new, as I have done here; but this is a ſpeculation that few perſons concern themſelves with, whereas all remember and apply the words relative to memory, juſt as they do other words. We may conclude therefore, that the difference of vividneſs and connection in the ideas, with the other aſſociates of recollections, are a ſufficient foundation for the proper uſe of the words relative to the memory, juſt as in other like caſes.

Sixthly, The peculiar imperfection of the memory in children tallies with the foregoing account of this faculty; and indeed this account may be conſidered as a groſs general hiſtory of the ſucceſſive growth of the memory, in paſſing from childhood to adult age. Children muſt learn by degrees the ideas of ſingle impreſſions, the cluſters which I call rudiments, and the moſt uſual connections and combinations of theſe. They have alſo the uſe of words, and of objects and incidents, as ſigns and ſymbols, with the proper method of reaſoning upon them, to learn; and during their novitiate in theſe things their memories muſt labour under great imperfections. It appears alſo, that the imperfections peculiar to children correſpond in kind as well as degree to the reaſons here aſſigned for them. Their not being able to digeſt paſt facts in order of time is, in great meaſure, owing to their not having the proper uſe of the ſymbols, whereby time is denoted.

Seventhly, The peculiar imperfection of the memory in aged perſons tallies alſo with the foregoing account. The vibrations and diſpoſitions to vibrate, in the ſmall medullary particles, and their aſſociations, are all ſo fixed by the calloſity of the medullary ſubſtance, and by repeated impreſſions and recurrencies, that new impreſſions can ſcarce enter, that they recur ſeldom, and that the parts which do recur bring in old trains from eſtabliſhed aſſociations, inſtead of continuing thoſe which were lately impreſſed. Hence one may almoſt predict what very old perſons will ſay or do upon common occurrences. Which is alſo the caſe frequently with perſons of ſtrong paſſions, for reaſons that are not very unlike. When old perſons relate the incidents of their youth with great preciſion, it is rather owing to the memory of many preceding memories, recollections, and relations than to the memory of the thing itſelf.

Eighthly, In recovering from concuſſions, and other diſorders of the brain, it is uſual for the patient to recover the power of remembering the then preſent common incidents for minutes, hours, and days, by degrees; alſo the power of recalling the events of his life preceding his illneſs. At length he recovers this laſt power perfectly, and at the ſame time forgets almoſt all that paſt in his illneſs, even thoſe things which he remembered, at firſt, for a day or two. Now the reaſon of this I take to be, that upon a perfect recovery the brain recovers its natural ſtate, *i. e.* all its former diſpoſitions to vibrate; but that ſuch as took place during the preternatural ſtate of the brain, *i. e.* during his illneſs, are all obliterated by the return of the natural ſtate. In like manner dreams, which happen in a peculiar ſtate of the brain, *i. e.* in *i. e.* in ſleep, vaniſh, as ſoon as vigilance, a different ſtate, takes place. But if they be collected immediately upon waking, and thus connected with the ſtate of vigilance, they may be remembered. But I ſhall have occaſion to be more explicit on this head in the next ſection.

Ninthly, It is very difficult to make any plauſible conjectures why ſome perſons of very weak judgments, not much below idiots, are endued with a peculiar extraordinary memory. This memory is generally the power of recollecting a large group of words, ſuppoſe, as thoſe of a ſermon, in a ſhort time after they are heard, with wonderful exactneſs and readineſs; but then the whole is obliterated, after a longer time, much more completely than in perſons of common memories and judgments. One may perhaps conjecture, that the brain receives all diſpoſitions to vibrate ſooner in theſe perſons, and lets them go ſooner, than in others. And the laſt may contribute to the firſt: for, new impreſſions may take place more deeply and preciſely, if there be few old ones to oppoſe them. The moſt perfect memory is that which can both receive moſt readily, and retain moſt durably. But we may ſuppoſe, that there are limits, beyond which theſe two different powers cannot conſiſt with each other.

Tenthly, When a perſon deſires to recollect a thing that has eſcaped him, ſuppoſe the name of a perſon, or viſible object, he recalls the viſible idea, or ſome other aſſociate, again and again, by a voluntary power, the deſire generally magnifying all the ideas and aſſociations; and thus bringing in the aſſociation and idea wanted, at laſt. However, if the deſire be great, it changes the ſtate of the brain, and has an oppoſite effect; ſo that the deſired idea does not recur, till all has ſubſided; perhaps not even then.

Eleventhly, All our voluntary powers are of the nature of memory; as may be eaſily ſeen from the foregoing account of it, compared with the account of the voluntary powers given in the firſt chapter. And it agrees remarkably with this, that, in morbid affections of the memory, the voluntary actions ſuffer a like change and imperfection.

Twelfthly, For the ſame reaſons the whole powers of the ſoul may be referred to the memory, when taken in a large ſenſe. Hence, though ſome perſons may have ſtrong memories with weak judgments, yet no man can have a ſtrong judgment with a weak original power of retaining and remembering.

SECT. V.

OF IMAGINATION, REVERIES, AND DREAMS.

PROP. XCI.

To examine how far the Phænomena of Imagination, Reveries, and Dreams, are agreeable to the foregoing Theory.

THE recurrence of ideas, eſpecially viſible and audible ones, in a vivid manner, but without any regard to the order obſerved in paſt facts, is aſcribed to the power of imagination or fancy. Now here we may obſerve, that every ſucceeding thought is the reſult either of ſome new impreſſion, or of an aſſociation with the preceding. And this is the common opinion. It is impoſſible indeed to attend ſo minutely to the ſucceſſion of our ideas, as to diſtinguiſh and remember for a ſufficient time the very impreſſion or aſſociation which gave birth to each thought; but we can do this as far as it can be expected to be done, and in ſo great a variety of inſtances, that our argument for the prevalence of the foregoing principle of aſſociation in all inſtances, except thoſe of new impreſſions, may be eſteemed a complete induction.

A reverie differs from imagination only in that the perſon being more attentive to his own thoughts, and leſs diſturbed by foreign objects, more of his ideas are deducible from aſſociation, and fewer from new impreſſions.

It is to be obſerved, however, that in all the caſes of imagination and reverie the thoughts depend, in part, upon the then ſtate of body or mind. A pleaſurable or painful ſtate of the ſtomach or brain, joy or grief, will make all the thoughts warp their own way, little or much. But this exception is as agreeable to the foregoing theory, as the general prevalence of aſſociation juſt laid down.

We come next to dreams. I ſay then, that dreams are nothing but the imaginations, fancies, or reveries of a ſleeping man; and that they are deducible from the three following cauſes, viz. Firſt, The impreſſions and ideas lately received, and particularly thoſe of the preceding day. Secondly, The ſtate of the body, particularly of the ſtomach and brain. And, Thirdly, Aſſociation.

That dreams are, in part, deducible from the impreſſions and ideas of the preceding day, appears from the frequent recurrence of theſe in greater or leſſer cluſters, and eſpecially of the viſible ones, in our dreams. We ſometimes take in ideas of longer date, in part, on account of their recency: however, in general, ideas that have not affected the mind for ſome days, recur in dreams only from the ſecond or third cauſe here aſſigned.

That the ſtate of the body affects our dreams, is evident from the dreams of ſick perſons, and of thoſe who labour under indigeſtions, ſpaſms, and flatulencies.

Laſtly, We may perceive ourſelves to be carried on from one thing to another in our dreams partly by aſſociation.

It is alſo highly agreeable to the foregoing theory to expect, that each of the three foregoing cauſes ſhould have an influence upon the trains of ideas, that are preſented in dreams.

Let us now ſee how we can ſolve the moſt uſual phænomena of dreams upon theſe principles.

Firſt, then, The ſcenes which preſent themſelves are taken to be real. We do not conſider them as the work of the fancy; but ſuppoſe ourſelves preſent, and actually ſeeing and hearing what paſſes.

Now this happens, Firſt, Becauſe we have no other reality to oppoſe to the ideas which offer themſelves, whereas in the common fictions of the fancy, while we are awake, there is always a ſet of real external objects ſtriking ſome of our ſenſes, and precluding a like miſtake there: or, if we become quite inattentive to external objects, the reverie does ſo far put on the nature of a dream, as to appear a reality.—Secondly, The trains of viſible ideas, which occur in dreams, are far more vivid than common viſible ideas; and therefore may the more eaſily be taken for actual impreſſions. For what reaſons theſe ideas ſhould be ſo much more vivid, I cannot preſume to ſay. I gueſs, that the excluſion of real impreſſions has ſome ſhare, and the increaſed heat of the brain may have ſome likewiſe. The fact is moſt obſervable in the firſt approaches of ſleep; all the viſible ideas beginning then to be more than uſually glaring.

Secondly, There is a great wildneſs and inconſiſtency in our dreams. For the brain, during ſleep, is in a ſtate ſo different from that in which the uſual aſſociations were formed, that they can by no means take place as they do during vigilance. On the contrary, the ſtate of the body ſuggeſts ſuch ideas, amongſt thoſe that have been lately impreſſed, as are moſt ſuitable to the various kinds and degrees of pleaſant and painful vibrations excited in the ſtomach, brain, or ſome other part. Thus a perſon who has taken opium, ſees either gay ſcenes, or ghaſtly ones, according as the opium excites pleaſant or painful vibrations in the ſtomach. Hence it will follow, that ideas will riſe ſucceſſively in dreams, which have no ſuch connection as takes place in nature, *in* actual impreſſions, nor any ſuch as is deducible from aſſociation. And yet, if they riſe up quick and vividly, one after another, as ſubjects, predicates, and other aſſociates, uſe to do, they will be affirmed of each other, and appear to hang together. Thus the ſame perſon appears in two places at the ſame time; two perſons appearing ſucceſſively in the ſame place coaleſce into one; a brute is ſuppoſed to ſpeak (when the idea of a voice comes from that quarter) or to handle; any idea, qualification, office, &c. coinciding in the inſtant of time with the idea of one's ſelf, or of another perſon, adheres immediately, &c. &c.

Thirdly, We do not take notice of, or are offended at, theſe inconſiſtencies; but paſs on from one to another. For the aſſociations, which ſhould lead us thus to take notice, and be offended, are, as it were, aſleep; the bodily cauſes alſo hurrying us on to new and new trains ſucceſſively. But if the bodily ſtate be ſuch as favours ideas of anxiety and perplexity, then the inconſiſtency, and apparent impoſſibility, occurring in dreams, are apt to give great diſturbance and uneaſineſs. It is to be obſerved likewiſe, that we forget the ſeveral parts of our dreams, very faſt in paſſing from one to another; and that this leſſens the apparent inconſiſtencies, and their influences.

Fourthly, It is common in dreams for perſons to appear to themſelves to be transferred from one place to another, by a kind of ſailing or flying motion. This ariſes from the change of the apparent magnitude and poſition of the images excited in the brain, this change being ſuch as a change of diſtance and poſition in ourſelves would have occaſioned. Whatever the reaſons be, for which viſible images are excited in ſleep, like to the objects with which we converſe when awake, the ſame reaſons will hold for changes of apparent magnitude and poſition alſo; and theſe changes in fixed objects, being conſtantly aſſociated with motions in ourſelves when awake, will infer theſe motions when aſleep. But then we cannot have the idea of the *vis inertiæ* of our own bodies, anſwering to the impreſſions in walking; becauſe the nerves of the muſcles either do not admit of ſuch miniature vibrations in ſleep; or do not tranſmit ideas to the mind in conſequence thereof; whence we appear to ſail, fly, or ride. Yet ſometimes a perſon ſeems to walk, and even to ſtrike, juſt as in other caſes he ſeems to feel the impreſſion of a foreign body on his ſkin.

Thoſe who walk and talk in their ſleep, have evidently the nerves of the muſcles concerned ſo free, as that vibrations can deſcend from the internal parts of the brain, the peculiar reſidence of ideas, into them. At the ſame time the brain itſelf is ſo oppreſſed, that they have ſcarce any memory. Perſons who read inattentively, *i. e.* ſee and ſpeak almoſt without remembering, alſo thoſe who labour under ſuch a morbid loſs of memory, as that though they ſee, hear, ſpeak, and act, *pro re nata*, from moment to moment, yet they forget all immediately, ſomewhat reſemble the perſons who walk and talk in ſleep.

Fifthly, Dreams conſiſt chiefly of viſible imagery. This agrees remarkably with the perpetual impreſſions made upon the optic nerves and correſponding parts of the brain during vigilance, and with the diſtinctneſs and vividneſs of the images impreſſed.

We may obſerve alſo, that the viſible imagery in dreams is compoſed, in a conſiderable degree, of fragments of viſible appearances lately impreſſed. For the diſpoſition to theſe vibrations muſt be greater than to others, *cæteris paribus*, at the ſame time that by the imperfection and interruption of the aſſociations, only fragments, not whole images, will generally appear. The fragments are ſo ſmall, and ſo intermixed with other fragments and appearances, that it is difficult to trace them up to the preceding day; the ſhortneſs of our memory contributing alſo not a little thereto.

It happens in dreams, that the ſame fictitious places are preſented again and again at the diſtance of weeks and months, perhaps during the whole courſe of life. Theſe places are, I ſuppoſe, compounded at firſt, probably early in youth, of fragments of real places, which we have ſeen. They afterwards recur in dreams, becauſe the ſame ſtate of brain recurs; and when this has happened for ſome ſucceſſions, they may be expected to recur at intervals during life. But they may alſo admit of variations, eſpecially before frequent recurrency has eſtabliſhed and fixed them.

Sixthly, It has been obſerved already, that many of the things which are preſented in dreams, appear to be remembered by us, or, at leaſt, as familiar to us; and that this may be ſolved by the readineſs with which they ſtart up, and ſucceed one another, in the fancy.

Seventhly, It has alſo been remarked, that dreams ought to be ſoon forgotten, as they are in fact; becauſe the ſtate of the brain ſuffers great changes in paſſing from ſleep to vigilance. The wildneſs and inconſiſtency of our dreams render them ſtill more liable to be forgotten. It is ſaid that a man may remember his dreams beſt by continuing in the ſame poſture in which he dreamt; which, if true, would be a remarkable confirmation of the doctrine of vibrations; ſince thoſe which take place in the medullary ſubſtance of the brain would be leaſt diſturbed and obliterated by this means.

Eighthly, The dreams which are preſented in the firſt part of the night are, for the moſt part, much more confuſed, irregular, and difficult to be remembered, than thoſe which we dream towards the morning; and theſe laſt are often rational to a conſiderable degree, and regulated according to the uſual courſe of our aſſociations. For the brain begins then to approach to the ſtate of vigilance, or that in which the uſual aſſociations were formed and cemented. However, aſſociation has ſome power even in wild and inconſiſtent dreams.

Cor. 1. As the prophecies were, many of them, communicated in the way of divine viſions, trances, or dreams, ſo they bear many of the foregoing marks of dreams. Thus they deal chiefly in viſible imagery; they abound with apparent impoſſibilities, and deviations from common life, of which yet the prophets take not the leaſt notice: they ſpeak of new things as of familiar ones; they are carried in the ſpirit from place to place; things requiring a long ſeries of time in real life, are tranſacted in the prophetical viſions, as ſoon as ſeen; they aſcribe to themſelves and others new names, offices, &c. every thing has a real exiſtence conferred upon it; there are ſingular combinations of fragments of viſible appearances; and God himſelf is repreſented in a viſible ſhape, which of all other things muſt be moſt offenſive to a pious *Jew*. And it ſeems to me, that theſe, and ſuch like criterions might eſtabliſh the genuineneſs of the prophecies, excluſively of all other evidences.

Cor. 2. The wildneſs of our dreams ſeems to be of ſingular uſe to us, by interrupting and breaking the courſe of our aſſociations. For, if we were always awake, ſome accidental aſſociations would be ſo much cemented by continuance, as that nothing could afterwards disjoin them; which would be madneſs.

Cor. 3. A perſon may form a judgment of the ſtate of his bodily health, and of his temperance, by the general pleaſantneſs or unpleaſantneſs of his dreams. There alſo many uſeful hints relating to the ſtrength of our paſſions deducible from them.

SECT. VI.

OF IMPERFECTIONS IN THE RATIONAL FACULTY.

PROP. XCII.

To examine how far Deviations from ſound Reaſon, and Alienations of Mind, are agreeable to the foregoing Theory.

MAD perſons differ from others in that they judge wrong of paſt or future facts of a common nature; that their affections and actions are violent and different from, or even oppoſite to, thoſe of others upon the like occaſions, and ſuch as are contrary to their true happineſs; that their memory is fallacious, and their diſcourſe incoherent; and that they loſe, in great meaſure, that conſciouſneſs which accompanies our thoughts and actions, and by which we connect ourſelves with ourſelves from time to time. Theſe circumſtances are variouſly combined in the various kinds and degrees of madneſs; and ſome of them take place in perſons of ſound minds, in certain degrees, and for certain ſpaces of time; ſo that here, as in other caſes, it is impoſſible to fix preciſe limits, and to determine where ſoundneſs of mind ends, and madneſs begins. I will make ſome ſhort remarks, deduced from the theory of theſe papers, upon the following ſtates of mind, which all bear ſome relation to one another, and all differ from the perfection of reaſoning natural to adults, according to the ordinary courſe of things, viz.

1. The erroneouſneſs of the judgment in children and idiots.
2. The dotage of old perſons.
3. Drunkenneſs.

4. The deliriums attending acute or other diſtempers.
5. The frequent recurrency of the ſame ideas in a courſe of ſtudy, or otherwiſe.
6. Violent paſſions.
7. Melancholy.
8. Madneſs.

OF THE ERRONEOUSNESS OF THE JUDGMENT IN CHILDREN AND IDIOTS.

Children often miſrepreſent paſt and future facts; their memories are fallacious; their diſcourſe incoherent; their affections and actions diſproportionate to the value of the things deſired and purſued; and the connecting conſciouſneſs is in them as yet imperfect. But all this follows naturally from the obſervations made above concerning the methods in which we learn to remember and relate paſt facts, to judge of future ones, to reaſon, and to expreſs ourſelves ſuitably to each occaſion; alſo in which our hopes and fears are made to depend upon ſymbols. No particular account is therefore required for theſe phænomena; they are ſtrictly natural; and many of the chief reaſons for the imperfection of the memory and judgment in children occurring perpetually, and being very obvious, it is not uſually ſuppoſed, that any particular account is required. However, if an adult ſhould become ſubject to a like erroneouſneſs, it would evidently be one ſpecies of madneſs; as fatuity or idiotiſm is. Here the brain labours under ſuch an original diſorder, as either not to receive a diſpoſition to the miniature vibrations in which ideas conſiſt, and whence voluntary motions are derived, but with great difficulty; or, if it receives ſuch diſpoſitions readily, they have not the uſual permanency; in both which caſes it is evident, that the memory, with all the faculties thereon depending, muſt continue in an imperfect ſtate, ſuch as is obſerved in idiots. The want of the connecting conſciouſneſs in children and idiots, and indeed in maniacs of various kinds, excites our pity in a peculiar manner, this connecting conſciouſneſs being eſteemed a principal ſource and requiſite of happineſs. Their helpleſsneſs, and the dangers to which they are expoſed without foreſeeing them, contribute alſo to enhance our compaſſion.

OF DOTAGE.

The dotage of old perſons is oftentimes ſomething more than a mere decay of memory. For they miſtake things preſent for others, and their diſcourſe is often foreign to the objects that are preſented to them. However, the imperfection of their memories in reſpect of impreſſions but juſt made, or at ſhort intervals of paſt time, is one principal ſource of their miſtakes. One may ſuppoſe here, that the parts of the brain, in which the miniature vibrations belonging to ideas have taken place, are decayed in a peculiar manner, perhaps from too great uſe, while the parts appropriated to the natural, vital, and animal motions, remain tolerably perfect. The ſinuſes of the brain are probably conſiderably diſtended in theſe caſes, and the brain itſelf in a languiſhing ſtate; for there ſeems to be a conſiderable reſemblance between the inconſiſtencies of ſome kinds of dotage, and thoſe of dreams. Beſides which it may be obſerved, that in dotage the perſon is often ſluggiſh and lethargic; and that as a defect of the nutritive faculty in the brain will permit the ſinuſes to be more eaſily diſtended, ſo a diſtention of the ſinuſes, from this or any other cauſe, may impede the due nutrition of the brain. We ſee that, in old perſons, all the parts, even the bones themſelves, waſte, and grow leſs. Why may not this happen to the brain, the origin of all, and ariſe from an obſtruction of the infiniteſimal veſſels of the nervous ſyſtem, this obſtruction cauſeth ſuch a degree of opacity, as greatly to abate, or even to deſtroy the powers of aſſociation and memory? At the ſame time vibrations, foreign to the preſent objects, may be excited from cauſes reſiding in the brain, ſtomach, &c. juſt as in ſleep.

OF DRUNKENNESS.

The common and immediate effect of wine is to diſpoſe to joy, *i. e.* to introduce ſuch kinds and degrees of vibrations into the whole nervous ſyſtem, or into the ſeparate parts thereof, as are attended with a moderate continued pleaſure. This it ſeems to do chiefly by impreſſing agreeable ſenſations upon the ſtomach and bowels, which are thence propagated into the brain, continue there, and alſo call up the ſeveral aſſociated pleaſures that have been formed from pleaſant impreſſions made upon the alimentary duct, or even upon any of the external ſenſes. But wine has alſo probably a conſiderable effect of the ſame kind, after it is abſorbed by the veins and lacteals, viz. by the impreſſions which it makes on the ſolids, conſidered as productions of the nerves, while it circulates with the fluids in an unaſſimilated ſtate, in the ſame manner, as has been already obſerved of opium; which reſembles wine in this reſpect alſo, that it produces one ſpecies of temporary madneſs. And we may ſuppoſe, that analogous obſervations hold with regard to all the medicinal and poiſonous bodies, which are found to produce conſiderable diſorders in the mind; their greateſt and moſt immediate effect ariſes from the impreſſions made on the ſtomach, and the diſorderly vibrations propagated thence into the brain; and yet it ſeems probable, that ſuch particles as are abſorbed, produce a ſimilar effect in circulating with the blood.

Wine, after it is abſorbed, muſt rarefy the blood, and conſequently diſtend the veins and ſinuſes, ſo as to make them compreſs the medullary ſubſtance, and the nerves themſelves, both in their origin and progreſs; it muſt therefore diſpoſe to ſome degree of a palſy of the ſenſations and motions; to which there will be a farther diſpoſition from the great exhauſtion of the nervous capillaments, and medullary ſubſtance, which a continued ſtate of gaiety and mirth, with the various expreſſions of it, has occaſioned.

It is moreover to be noted, that the pleaſant vibrations producing this gaiety, by riſing higher and higher perpetually, as more wine is taken into the ſtomach and blood veſſels, come at laſt to border upon, and even to paſs into, the diſagreeable vibrations belonging to the paſſions of anger, jealouſy, envy, &c. more eſpecially if any of the mental cauſes of theſe be preſented at the ſame time.

Now it ſeems, that, from a compariſon of theſe and ſuch like things with each other, and with what is delivered in other parts of theſe papers, the peculiar temporary madneſs of drunken perſons might receive a general explanation. Particularly it ſeems natural to expect, that they ſhould at firſt be much diſpoſed to mirth and laughter, with a mixture of ſmall inconſiſtencies and abſurdities; that theſe laſt ſhould increaſe from the vivid trains which force themſelves upon the brain, in oppoſition to the preſent reality; that they ſhould loſe the command and ſtability of the voluntary motions from the prevalence of confuſed vibrations in the brain, ſo that thoſe appropriated to voluntary motion cannot deſcend regularly as uſual; but that they ſhould ſtagger, and ſee double: that quarrels and contentions ſhould ariſe after ſome time; and all end at laſt in a temporary apoplexy. And it is very obſervable, that the free uſe of fermented liquors diſpoſes to paſſionateneſs, to diſtempers of

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the head, to melancholy, and to downright madneſs; all which things have alſo great connections with each other.

The ſickneſs and head-ach which drunkenneſs occaſions the ſucceeding morning, ſeem to ariſe, the firſt from the immediate impreſſions made on the nerves of the ſtomach; the ſecond from the peculiar ſympathy which the parts of the head, external as well as internal, have with the brain, the part principally affected in drunkenneſs, by deriving their nerves immediately from it.

OF DELIRIUMS.

I come next to conſider the deliriums which ſometimes attend diſtempers, eſpecially acute ones. In theſe a diſagreeable ſtate is introduced into the nervous ſyſtem by the bodily diſorder, which checks the riſe of pleaſant aſſociations, and gives force and quickneſs to diſguſtful ones; and which conſequently would of itſelf alone, if ſufficient in degree, vitiate and diſtort all the reaſonings of the ſick perſon. But beſides this, it ſeems, that, in the deliriums attending diſtempers, a vivid train of viſible images forces itſelf upon the patient's eye, and that either from a diſorder in the nerves and blood veſſels of the eye itſelf, or from one in the brain, or one in the alimentary duct, or, which is moſt probable, from a concurrence of all theſe. It ſeems alſo that the wild diſcourſe of delirious perſons is accommodated to this train in ſome imperfect manner; and that it becomes ſo wild, partly from the incoherence of the parts of this train, partly from its not expreſſing even this incoherent train adequately, but deviating into ſuch phraſes as the vibrations excited by the diſtemper in the parts of the brain correſponding to the auditory nerves, or in parts ſtill more internal, and conſequently the ſeats of ideas purely intellectual, produce by their aſſociated influence over the organs of ſpeech.

That delirious perſons have ſuch trains forced upon the eye from internal cauſes, appears probable from hence, that when they firſt begin to be delirious, and talk wildly, it is generally at ſuch times only as they are in the dark, ſo as to have all viſible objects excluded; for, upon bringing a candle to them, and preſenting common objects, they recover themſelves, and talk rationally, till the candle be removed again. For hence we may conclude, that the real objects overpower the viſible train from internal cauſes, while the delirium is in its infancy; and that the patient relapſes, as ſoon as he is ſhut up in the dark, becauſe the viſible train from internal cauſes overpowers that which would riſe up, was the perſon's nervous ſyſtem in a natural ſtate, according to the uſual courſe of aſſociation, and the recurrent recollection of the place and circumſtances in which he is ſituated. By degrees the viſible train, from internal cauſes, grows ſo vivid, by the increaſe of the diſtemper, as even to overpower the impreſſions from real objects, at leaſt frequently, and in a great degree, and ſo as to intermix itſelf with them, and to make an inconſiſtency in the words and actions; and thus the patient becomes quite delirious.

Perſons inclining to be delirious in diſtempers are moſt apt to be ſo in going to ſleep, and in waking from ſleep; in which circumſtances the viſible trains are more vivid, than when we are quite awake, as has been obſerved above.

It caſts alſo ſome light upon this ſubject, that tea and coffee will ſometimes occaſion ſuch trains; and that they ariſe in our firſt attempts to ſleep after theſe liquors.

As death approaches, the deliriums attending diſtempers abound with far more incoherences and inconſiſtencies, than any other ſpecies of alienations of the mind; which may eaſily be conceived to be the natural reſult of the entire confuſion and diſorder which then take place in the nervous ſyſtem. However, there are ſome caſes of death, where the nervous ſyſtem continues free from this confuſion to the laſt, as far as the by-ſtanders can judge.

OF THE FREQUENT RECURRENCY OF THE SAME IDEAS.

When a perſon applies himſelf to any particular ſtudy, ſo as to fix his attention deeply on the ideas and terms belonging to it, and to be very little converſant in thoſe of other branches of knowledge, it is commonly obſerved, that he becomes narrow-minded, ſtrongly perſuaded of the truth and value of many things in his own particular ſtudy, which others think doubtful or falſe, or of little importance, and after ſome time ſubject to low ſpirits, and the hypochondriacal diſtemper. Now all this follows from obſervations already made. The perpetual recurrency of particular ideas and terms makes the vibrations belonging thereto become more than ordinarily vivid, converts feeble aſſociations into ſtrong ones, and enhances the ſecondary ideas of dignity and eſteem, which adhere to them, at the ſame time that all theſe things are diminiſhed in reſpect of other ideas and terms, that are kept out of view; and which, if they were to recur in due proportion, would oppoſe and correct many aſſociations in the particular ſtudy, which are made not according to the reality of things, and keep down our exorbitant opinions of its importance. The ſame perpetual recurrency of vibrations, affecting one and the ſame part of the brain, in nearly one and the ſame manner, muſt irritate it at laſt, ſo as to enter the limits of pain, and approach to the ſtates peculiar to fear, anxiety, deſpondency, peeviſhneſs, jealouſy, and the reſt of the tribe of hypochondriacal paſſions.

Sleep, which preſents ideas at hazard, as one may ſay, and with little regard to prior aſſociations, ſeems to be of the greateſt uſe in keeping off the hypochondriacal diſtemper in ſuch perſons: however, without a change of ſtudies, this, with great narrow-mindedneſs, will probably come at laſt.

It follows from the ſame method of reaſoning, that ſince the concerns of religion are infinite, ſo that we can never over-rate them, we ought to make the ideas, motives, and affections, of this kind, recur as often as poſſible. And if this be done in a truly catholic ſpirit, with all that variety of actions which our duty to God, our neighbour, and ourſelves, requires, there will be no danger of introducing either narrow-mindedneſs or hypochondriaciſm. And it ought to be eſteemed the ſame kind and degree of alienation of mind to undervalue a thing of great importance, as to overvalue one of ſmall.

OF VIOLENT PASSIONS.

Perſons that are under the influence of ſtrong paſſions, ſuch as anger, fear, ambition, diſappointment, have the vibrations attending the principal ideas ſo much increaſed, that theſe ideas cling together, *i. e.* are aſſociated in an unnatural manner; at the ſame time that the eagerneſs and violence of the paſſion prevent the formation of ſuch aſſociations, or obſcure them, if already formed, as are requiſite for the right apprehenſion of the paſt and future facts, which are the objects of this paſſion. Violent paſſions muſt therefore diſorder the underſtanding and judgment, while they laſt; and if the ſame paſſion returns frequently, it may have ſo great an effect upon the aſſociations, as that the intervention of foreign ideas ſhall not be able to ſet things to rights, and break the unnatural bond. The ſame increaſe of vibrations makes all the principal ideas appear to affect *ſelf*, with the peculiar intereſting concern ſuppoſed to flow from perſonal identity; ſo that theſe vibrations exert a reflected influence upon themſelves by this means. And thus it appears, that all violent paſſions muſt be temporary madneſſes, and all habits of them permanent ones, agreeably to the judgment of the wiſe and good in theſe things. It appears alſo, that violent fits of paſſion, and frequent recurrencies of them, muſt, from the nature of the body, often tranſport perſons, ſo that they ſhall not be able to recover themſelves, but fall within the limits of the diſtemper called madneſs emphatically.

OF MELANCHOLY.

The next ſpecies of alienations of the mind is melancholy. Vapours, hypochondriacal and hyſterical diſorders, are comprehended under this claſs. The cauſes of it are ſelf-indulgence in eating and drinking, and particularly in fermented liquors, want of due bodily labour, injuries done to the brain by fevers, concuſſions, &c. too much application of the mind, eſpecially to the ſame objects and ideas, violent and long-continued paſſions, profuſe evacuations, and an hereditary diſpoſition; which laſt we may ſuppoſe to conſiſt chiefly in an undue make of the brain.

In women the uneaſy ſtates of the *uterus* are propagated to the brain, both immediately and mediately, *i. e.* by firſt affecting the ſtomach, and thence the brain. In men the original diſorder often begins, and continues for a long time, chiefly in the organs of digeſtion.

The *cauſa proxima* of melancholy is an irritability of the medullary ſubſtance of the brain, diſpoſing it upon ſlight occaſions to ſuch vibrations as enter the limits of pain; and particularly to ſuch kinds and degrees, as belong to the uneaſy paſſions of fear, ſorrow, anger, jealouſy, &c. And as theſe vibrations, when the paſſions are not in great exceſs, do not much trangreſs the limits of pleaſure, it will often happen that hypochondriac and hyſteric perſons ſhall be apt to be tranſported with joy from trifling cauſes, and be, at times, diſpoſed to mirth and laughter. They are alſo very fickle and changeable, as having their deſires, hopes, and fears, increaſed far beyond their natural magnitude, when they happen to fall in with ſuch a ſtate of brain as favours them.

It often happens to theſe perſons to have very abſurd deſires, hopes, and fears; and yet, at the ſame time, to know them to be abſurd; and, in conſequence thereof, to reſiſt them. While they do this, we may reckon the diſtemper within the bounds of melancholy; but when they endeavour to gratify very abſurd deſires, or are permanently perſuaded of the reality of very groundleſs hopes and fears, and eſpecially if they loſe the connecting conſciouſneſs in any great degree, and violate the rules of decency and virtue (the aſſociations of this kind being overpowered, as it were, in the ſame manner as they are ſometimes in dreams), we may reckon the diſtemper to have paſſed into madneſs, ſtrictly ſo called; of which I now come to ſpeak in a general brief way.

OF MADNESS.

The cauſes of madneſs are of two kinds, bodily and mental. That which ariſes from bodily cauſes is nearly related to drunkenneſs, and to the deliriums attending diſtempers. That from mental cauſes is of the ſame kind with temporary alienations of the mind during violent paſſions, and with the prejudices and opinionativeneſs, which much application to one ſet of ideas only occaſions.

We may thus diſtinguiſh the cauſes for the more eaſy conception and analyſis of the ſubject; but, in fact, they are both united for the moſt part. The bodily cauſe lays hold of that paſſion or affection, which is moſt diſproportionate; and the mental cauſe, when that is primary, generally waits till ſome bodily diſtemper gives it full ſcope to exert itſelf. Agreeably to this, the prevention and cure of all kinds of madneſs require an attention both to the body and mind; which coincides in a particular manner with the general doctrine of theſe papers.

It is obſerved, that mad perſons often ſpeak rationally and conſiſtently upon the ſubjects that occur, provided that ſingle one which moſt affects them, be kept out of view. And the reaſon of this may be, that whether they firſt became mad, becauſe a particular, original, mental uneaſineſs falls in with an accidental, bodily diſorder; or becauſe an original, bodily diſorder falls in with an accidental mental one; it muſt follow, that a particular ſet of ideas ſhall be extremely magnified, and, conſequently, an unnatural aſſociation of ſameneſs or repugnancy between them generated, all other ideas and aſſociations remaining nearly the ſame. Thus, ſuppoſe a perſon, whoſe nervous ſyſtem is diſordered, to turn his thoughts accidentally to ſome barely poſſible good or evil. If the nervous diſorder falls in with this, it increaſes the vibrations belonging to its idea ſo much, as to give it a reality, a connection with *ſelf*. For we diſtinguiſh the recollection and anticipation of things relating to ourſelves, from thoſe of things relating to other perſons, chiefly by the difference of ſtrength in the vibrations, and in their coaleſcences with each other. When one falſe poſition of this kind is admitted, it begets more of courſe, the ſame bodily and mental cauſes alſo continuing; but then this proceſs ſtops after a certain number of falſe poſitions are adopted from their mutual inconſiſtency (unleſs the whole nervous ſyſtem be deranged); and it is often confined to a certain kind, as the iraſcible, the terrifying, &c.

The memory is often much impaired in madneſs, which is both a ſign of the greatneſs of the bodily diſorder, and a hindrance to mental rectification; and therefore a bad prognoſtic. If an oppoſite ſtate of body and mind can be introduced early, before the unnatural aſſociations are too much cemented, the madneſs is cured; if otherwiſe, it will remain, though both the bodily and mental cauſe ſhould be at laſt removed.

Inquiries after the philoſopher's ſtone, the longitude, &c. to which men are prompted by ſtrong ambitious, or covetous deſires, are often both cauſe and effect, in reſpect of madneſs. Exceſſive fits of anger and fear are alſo found often to hurry perſons into madneſs.

In diſſections after madneſs the brain is often found dry, and the blood veſſels much diſtended; which are arguments, that violent vibrations took place in the internal parts of the brain, the peculiar reſidence of ideas and paſſions; and that it was much compreſſed, ſo as to obſtruct the natural courſe of aſſociation.

As in mad perſons the vibrations in the internal parts of the brain are preternaturally increaſed, ſo they are defective in the external organs, in the glands, &c. Hence, maniacs eat little, are coſtive, make little water, and take ſcarce any notice of external impreſſions. The violence of the ideas and paſſions may give them great muſcular ſtrength upon particular occaſions, when the violent vibrations deſcend from the internal parts of the brain into the muſcles, according to former aſſociations of theſe with the voluntary motions (the ſame increaſe of vibrations in the internal parts of the brain which hinders the aſcending vibrations of ſenſation, augmenting the deſcending ones of motion). But maniacs are often very ſluggiſh, as well as inſenſible, from the great prevalence of the ideal vibrations; juſt as perſons in a ſtate of deep attention are. An accurate hiſtory of the ſeveral kinds of madneſs from thoſe phyſicians, who are much converſant with this diſtemper, is greatly wanted, and it would probably receive conſiderable light from this theory.

Religious conſiderations are the beſt preſervative in hereditary or other tendencies to madneſs; as being the only ſure means of reſtraining violent paſſions, at the ſame time that they afford a conſtant indefinite hope, mixed with a filial awe and fear; which things are eminently qualified to keep up a ſteadineſs and ſobriety of mind, and to incite us to ſuch a courſe of action, as adds inceſſantly to the hope, and diminiſhes the fear. However, bodily labour, with a variety of mental occupations, and a conſiderable abſtemiouſneſs in the quantity and quality of diet, ought always to be joined.

SECT. VII.

OF THE INTELLECTUAL FACULTIES OF BRUTES.

PROP. XCIII.

To examine how far the Inferiority of Brutes to Mankind in intellectual Capacities is agreeable to the foregoing Theory.

If the doctrines of vibrations and aſſociation be found ſufficient to ſolve the phænomena of ſenſation, motion, ideas, and affections, in men, it will be reaſonable to ſuppoſe, that they will alſo be ſufficient to ſolve the analogous phænomena in brutes. And, converſely, it ſeems probable, that an endeavour to apply and adapt theſe doctrines to brutes will caſt ſome light and evidence upon them, as they take place in men. And thus the laws of vibrations and aſſociation may be as univerſal in reſpect of the nervous ſyſtems of animals of all kinds, as the law of circulation is with reſpect to the ſyſtem of the heart and blood veſſels; and their powers of ſenſation and motion be the reſult of theſe three laws, viz. circulation, vibrations, and aſſociation, taken together. Theſe three laws may alſo be moſt cloſely united in their ultimate cauſe and ſource, and flow in all their varieties from very ſimple principles. At leaſt this is the tenor of nature in many ſimilar caſes.

As the whole brute creation differs much from, and is far inferior to man, in intellectual capacities; ſo the ſeveral kinds of animals differ much from each other in the ſame reſpect. But I ſhall, in this ſection, confine myſelf chiefly to the conſideration of the firſt difference, viz. of that between mankind and the brute creation in general; and endeavour to aſſign ſuch reaſons for it, as flow from, or are agreeable to, the theory of theſe papers. We may ſuppoſe then, that brutes in general differ from, and are inferior to man, in intellectual capacities, on the following accounts:

Firſt, the ſmall proportional ſize of their brains.

Secondly, The imperfection of the matter of their brains, whereby it is leſs fitted for retaining a large number of miniatures, and combining them by aſſociation, than man's.

Thirdly, Their want of words, and ſuch like ſymbols.

Fourthly, The inſtinctive powers which they bring into the world with them, or which riſe up from internal cauſes, as they advance towards adult age.

Fifthly, The difference between the external impreſſions made on the brute creation, and on mankind.

Firſt, then, As the brains of brutes are leſs in proportion to the bulk of the other parts, than thoſe of men; and as the internal parts of the brain appear from theſe papers to be the peculiar ſeat of ideas, and intellectual affections; it ſeems very natural to expect, that brutes ſhould have a far leſs variety of theſe than men. The parts which intervene between the optic and auditory nerves, being proportionably leſs, for inſtance, in brutes, will not admit of ſo great a variety of aſſociations between the ſeveral ideas of theſe ſenſes, becauſe the optic and auditory nerves cannot have ſo great a variety of connections and communications with each other.

To this it is to be added, that the internal parts belonging to the olfactory nerves, and, perhaps, thoſe belonging to the nerves of taſte, take up, probably, a greater proportional part of the medullary ſubſtance of the brain than in us, ſince moſt brutes have the ſenſe of ſmell, and perhaps that of taſte in greater perfection than we have. There will therefore be ſtill leſs room left for the variety of intercourſes between the optic and auditory nerves in the medullary ſubſtance of the brain. And yet it is evident, from obvious obſervations, as well as from the whole tenor of theſe papers, that the eye and ear, with their aſſociations, are the chief ſources of intellect; and that the greateſt part of the pleaſures and pains of human life ariſe from viſible and audible impreſſions, which in themſelves afford neither pleaſure nor pain.

Thus it is natural to expect, that the happineſs and miſery of brutes ſhould depend principally, and in a direct manner, on the impreſſions made upon their groſs ſenſes, whilſt that of mankind ariſes, in great meaſure, from long trains of aſſociated ideas and emotions, which enter chiefly by the eye and ear. And it ſeems to me a very ſtriking coincidence, that mankind ſhould at the ſame time exceed the brute creation in the variety of their ideas, and in the proportional largeneſs of that part of the body which is the peculiar ſeat of theſe.

The ſame proportional largeneſs may, as it were, detain the vibrations which aſcend from external impreſſions up to the brain, and ſo prevent that freedom of deſcent into the muſcular ſyſtem which takes place in brutes; and which diſpoſes them to move more early, and more readily, in conſequence of direct impreſſions, than men, at the ſame time that they have a far leſs command, in reſpect of voluntary motion. But this difference depends, in great meaſure, upon the conſiderations that follow, as will be ſeen.

Secondly, That the very conſtitution and texture of the nervous ſyſtem, in its infiniteſimal veſſels, ſhould differ in brutes from that of men, appears highly reaſonable to be expected. And ſince the lives of brutes fall, in general, far ſhort of that of man, alſo ſince the quadrupeds (which reſemble man more than other animals) are far more hairy, and fowls have feathers, it appears probable, that the texture of the nervous ſyſtem in brutes ſhould tend more to calloſity, and fixedneſs, in its diſpoſitions to vibrate, than in men. The brains of young brute animals will therefore be ſooner able to retain miniatures than thoſe of children, as tending more to firmneſs and fixedneſs in their ultimate texture and conſtitution; at the ſame time that this texture will unfit them for receiving a variety. To which, if we add the ſhortneſs of their lives, and conſequently of their aſcent to the ſummit of adult age; which aſcent is the proper time for receiving inſtruction; it is eaſy to ſee, that on this double account, as well as that mentioned under the foregoing head, they muſt fall far ſhort of mankind in the number of their intellectual ideas, pleaſures, and pains.

It follows from the ſame method of reaſoning, that the few diſpoſitions to miniature vibrations, which are generated in brutes, may be as perfect in their kinds; and conſequently the memory, and ſhort, direct ratiocination depending thereon, as perfect alſo, as the analogous things in man. Nay, they may be more ſo, if the particular animal under conſideration excel man in the acuteneſs and preciſion of thoſe ſenſes, whoſe ideas make a principal part of this ratiocination. Now it appears, that moſt quadrupeds exceed us in the acuteneſs of the ſmell, and in the power of diſtinguiſhing a variety of ſmells. And many birds ſeem to be able to ſee diſtinctly at much greater diſtances. However, our auditory nerves, and the regions of the brain correſponding thereto appear far better fitted for retaining a variety of miniatures of articulate ſounds; and our optic nerves, and the regions of the brain correſponding thereto, for retaining a variety of miniatures of ſhapes and colours. And, next to man, quadrupeds, and particularly monkeys, dogs, and horſes, ſeem to have theſe regions of the brain in the greateſt perfection.

If the texture of the brains of animals here conſidered be alſo, in part, the cauſe of their being covered with hair, wool, briſtles, feathers, &c. it may, from this its effect, diſpoſe them to greater ſtrength and expertneſs in their motions, and that more early, than happens to men. For all theſe are *electrics per ſe*, and conſequently may firſt have a conſiderable degree of this power communicated to them by the heat of the circulating blood; and then, not being able to tranſmit it to the air, which is alſo an *electric per ſe*, may reflect it upon the muſcles, and thereby diſpoſe them to ſomewhat greater activity. It is well known, that the manes of horſes, and backs of cats, are made electric by their vital powers. It may farther be obſerved, that the hoofs of animals are *electrics per ſe*, and that the feathers of water-fowl repel the water; whence the electric virtue may be kept from running off to the earth and water reſpectively. However, we ought not to lay much ſtreſs upon this electric virtue in the muſcular fibres of brutes (if there be any ſuch virtue) in order to account for the ſuperior and more early power of animals, in reſpect of ordinary motions. The texture of the fibres of the muſcles, and that of the brain, muſt have the principal ſhare in this effect.

It is alſo to be conſidered, that as they have far fewer voluntary motions, on account of having far fewer ideas, ſo they may arrive at a greater perfection in the automatic ones, and the ſmall number of voluntary ones which they do perform, on this account. Man is diſtracted, as it were, by the endleſs variety of his ideas, and voluntary motions: and it is notorious, that none beſides extraordinary geniuſes arrive at perfection in any conſiderable variety; whereas a perſon of ſmall natural capacity, by ſelecting ſome one branch of ſcience, or manual art, and applying himſelf to this alone, may perform wonders. Nay, there have been inſtances of perſons not much removed from idiotiſm, who could perform the arithmetical operations by memory, far better than men of good underſtandings, well verſed in thoſe operations; which is a thing ſomewhat analogous to the extraordinary ſagacity in inveſtigating and concluding, which brutes diſcover, in reſpect of ſome particular things.

Thirdly, The next circumſtance, which renders brutes far inferior to man in intellectual acquiſitions, is their want of ſymbols, ſuch as words, whereby to denote objects, ſenſations, ideas, and combinations of ideas. This may appear from ſeveral conſiderations. Thoſe men who happen to be born in a country where the mother-tongue is copious and preciſe, who apply themſelves to the ſtudy of their mother-tongue, who, beſides this, learn one or more foreign tongues, &c. get, by theſe means, a conſiderable ſhare of the knowledge of things themſelves, learn to remark, prove, diſprove, and invent, and *cæteris paribus*, make a quicker progreſs in mental accompliſhments, than others. On the contrary the mental improvement of perſons born deaf is extremely retarded by their incapacity of having things ſuggeſted by articulate ſounds, or the pictures of theſe, and alſo by their not being able to ſolve the inverſe problem, and denote their own trains of thought by adequate ſymbols. Words are the ſame kind of helps in the inveſtigation of qualities, as algebraical ſymbols, and methods are in reſpect of quantity, as has been already remarked. Perſons born deaf cannot therefore make any great progreſs in the knowledge of cauſes and effects, in abſtracted and philoſophical matters; but muſt approach, as it were, to the ſtate of the brute creation. On the contrary, brute creatures, that have much intercourſe with mankind, ſuch as dogs and horſes, by learning the uſe of words and ſymbols of other kinds, become more ſagacious than they would otherwiſe be.

And if particular pains be taken with them, their docility and ſagacity, by means of ſymbols, ſometimes ariſe to a very ſurprizing degree.

Parrots might be thought, according to this view of the preſent ſubject, to have ſome particular advantages over quadrupeds by their being able to pronounce words; ſince, as has been obſerved before, the attempts which children make to apply words to things, aſſiſt them very much in underſtanding the applications made by others. But parrots do not ſeem to ſpeak from any particular acuteneſs and preciſion in the auditory nerves, and parts of the brain correſponding thereto, having no cochlea, but from the perfection and pliableneſs of their vocal organs, in which they exceed other birds; as birds in general do beaſts. And it is reaſonable to think, that quadrupeds, which reſemble man ſo nearly in the make of the organ of hearing, as well as in other parts, and which alſo have naturally much more intercourſe with man (being fellow-inhabitants of the earth) than birds (which inhabit the air), ſhould likewiſe have a greater faculty of diſtinguiſhing the articulate ſounds of man's voice, retaining their miniatures, and applying them to the things ſignified, than birds; which ſeems evidently to be the caſe. Sagacious quadrupeds may therefore be ſaid to reſemble dumb perſons arrived at adult age, who are poſſeſſed of much knowledge, which yet they cannot expreſs, except by geſtures, by dumb ſhew: whereas parrots, as before remarked, reſemble children; theſe having many words with very little knowledge annexed to them.

Apes and monkeys, of the ſeveral kinds, ſeem to approach neareſt to man, in the general faculty of reaſoning, and drawing concluſions; but in particular things, eſpecially where inſtinct prevails, ſome other brutes far exceed them; as indeed ſuch brutes do man himſelf in a few, on account of the peculiar acuteneſs of the ſenſe of ſmell, and the ſame inſtinct.

I reckon the want of articulate ſounds to be one of the reaſons why brutes are ſo much inferior to men in intellectual capacities; becauſe it appears, from the foregoing and other conſiderations of the ſame kind, that it is ſo. But this is no imperfection upon the whole. The proportional ſmallneſs of their brains, the texture of theſe, their inſtincts, and their external circumſtances, are ſuch, that they do not want language much; that they could make no great uſe of it, had they proper organs for ſpeaking; and that they would probably be loſers, upon the whole, by having it. The efficient and final cauſes are here ſuited to each other, as in all other caſes; ſo that no circumſtance can be changed for the better, *cæteris manentibus.*

Fourthly, Let us come to the inſtinctive powers of animals. Theſe are a point of a very difficult conſideration. They are evidently not the reſult of external impreſſions by means of the miniatures of theſe, their aſſociations and combinations, in the manner according to which I have endeavoured to ſhew, that the rational faculties of mankind are formed and improved; and yet, in the inſtances to which they extend, they very much reſemble the rational faculties of mankind. Animals, in preparing and providing for themſelves and their young, in future exigencies, proceed in the ſame manner as a perſon of good underſtanding, who foreſaw the event, would do; and this, even though they be a little put out of their way. And in this they much reſemble perſons of narrow capacities and acquiſitions, who yet excel greatly in ſome particular art or ſcience; of which there are many inſtances. Such perſons ſhew great ingenuity in the things to which they are accuſtomed, and in ſome others that border upon them within certain limits, ſo as to ſhew great ingenuity ſtill, though put a little out of their way; but if they be put much out of their way, or queſtioned about things that are entirely foreign to the art or ſcience in which they excel, they are quite loſt and confounded,

Let us ſuppoſe this to be the caſe, and then the inquiry concerning inſtinct in brutes will be reduced to this, viz. By what means the nervous ſyſtems of brutes are made to put on diſpoſitions to miniature vibrations, analogous to thoſe which take place in the perſons here conſidered; and which are in them the reſult of foregoing impreſſions, if we admit the theory of theſe papers. Now, to me, there ſeems no difficulty in aſcribing this to the mere bodily make in brutes, ſo that miniature vibrations, ſuch as anſwer in us to ideas, and voluntary motions, ſhall ſpring up in them at certain ages and ſeaſons of the year, and mix themſelves with impreſſions, and acquired ideas, ſo as to be, in general, ſuitable to them; and, in general, to direct the brute creatures in what manner to provide for, and preſerve themſelves and their young.

This would be a kind of inſpiration to brutes, mixing itſelf with, and helping out, that part of their faculties which correſponds to reaſon in us, and which is extremely imperfect in them. Only this inſpiration might be called natural, as proceeding from the ſame ſtated laws of matter and motion as the other phænomena of nature; whereas the inſpiration of the ſacred writers appears to be of a much higher ſource, ſo as to be termed ſupernatural properly, in contradiſtinction to all knowledge reſulting from the common laws of nature. And yet it may reſult from ſome higher laws of nature. For ſacred inſpiration would loſe nothing of its authority, though it ſhould appear to be within ſuch laws, as by their fixedneſs might be termed nature: and indeed all differences in theſe things, after the facts are once ſettled, will be found, upon due inquiry, to be merely verbal.

Fifthly, The laſt cauſe here aſſigned for the great difference and inferiority of brutes, in reſpect of intellectual capacities, is the difference in the events and incidents of their lives. They converſe with far fewer objects than men, and both the objects and pleaſures of feeling, taſte, and ſmell, have a far greater proportional ſhare in the ſum total, than in us. Now, as in men, the common events and incidents of life give a turn to the whole frame of mind, and either enlarge the intellectual capacities, if they be various, or narrow them, if the ſame occurrences return again and again perpetually; ſo, independently of all the foregoing conſiderations, the ſameneſs, paucity, and relation to mere ſenſe, of the impreſſions made on brutes, muſt infer a great narrowneſs of underſtanding.

From all theſe things put together, it appears very conceivable, how the mental faculties of brutes ſhould, conſiſtently with the doctrines of vibrations and aſſociation, be what they are, in fact, found to be. And though I ſuppoſe with *Deſcartes*, that all their motions are conducted with mere mechaniſm; yet I do not ſuppoſe them to be deſtitute of perception, but that they have this in a manner analogous to that which takes place in us; and that it is ſubjected to the ſame mechanical laws as the motions. Whether the ideal vibrations, which take place in the medullary ſubſtances of their brains, be the reſult of former impreſſions, or the mere offspring of their vital and natural powers, agreeably to the foregoing hypotheſis concerning inſtinct, or the compound effect of both, which we may preſume to be generally the caſe, I always ſuppoſe, that correſponding feelings, and affections of mind, attend upon them, juſt as in us. And the brute creatures prove their near relation to us, not only by the general reſemblance of the body, but by that of the mind alſo; inaſmuch as many of them have moſt of the eminent paſſions in ſome imperfect degree, and as there is, perhaps, no paſſion belonging to human nature, which may not be found in ſome brute creature in a conſiderable degree.

The brutes ſeem ſcarce ever able to arrive at any proper ſelf-intereſt of the abſtract and refined kind, at conſciouſneſs, ſo as to compare and connect themſelves with themſelves in different ſituations, or at any idea and adoration of God; and this from the narrowneſs of their capacities and opportunities in general, but particularly from their want of ſymbols.

The ſame want of ſymbols muſt make all their reaſonings and affections, which reſemble ours in the general, be, however, conſiderably different in particulars, and far leſs complex; but it is ſufficient to entitle them to the names of ſagacity, cunning, fear, love, &c. by which ours are denoted, that the trains of ideal vibrations in their brains bear a general reſemblance to the correſponding ones in ours, ſpring from like cauſes, and produce like effects.

The power of aſſociation over brutes is very evident in all the tricks which they are taught; and the whole nature of each brute, which has been brought up amongſt others of the ſame ſpecies, is a compound of inſtinct, his own obſervation and experience, and imitation of thoſe of his own ſpecies. Inſtinct ſeems to have exerted its whole influence when the creature is arrived at maturity, and has brought up young; ſo that nothing new can be expected from it afterwards. But their intellectual acquiſitions from obſervation and imitation continue; whence old brutes are far more cunning, and can act far better, *pro re nata*, than young ones.

It ought always to be remembered in ſpeaking on this ſubject, that brutes have more reaſon than they can ſhew, from their want of words, from our inattention,

attention, and from our ignorance of the import of thoſe ſymbols, which they do uſe in giving intimations to one another, and to us.

We ſeem to be in the place of God to them, to be his vicegerents, and empowered to receive homage from them in his name. And we are obliged by the ſame tenure to be their guardians and benefactors.

CHAP. IV.

Of the SIX CLASSES *of* INTELLECTUAL PLEASURES *and* PAINS.

I HAVE now diſpatched the hiſtory and analyſis of the ſenſations, motions, and ideas; and endeavoured to ſuit them, as well as I could, to the principles laid down in the firſt chapter. My next buſineſs, is to inquire particularly into the riſe and gradual increaſe of the pleaſures and pains of imagination, ambition, ſelf-intereſt, ſympathy, theopathy, and the moral ſenſe; and to ſee how far theſe can be deduced, in the particular forms and degrees that are found to prevail, in fact, from the ſenſible pleaſures and pains, by means of the general law of aſſociation. As to that of vibrations, it ſeems of little importance in this part of the work, whether it be adopted or not. If any other law can be made the foundation of aſſociation, or conſiſtent with it, it may alſo be made conſiſtent with the analyſis of the intellectual pleaſures and pains, which I ſhall here give. I do not think there is any other law that can; on the contrary, there ſeems to be ſo peculiar an aptneſs in the doctrine of vibrations, for explaining many of the phænomena of the paſſions, as almoſt excludes all others.

Now it will be a ſufficient proof, that all the intellectual pleaſures and pains are deducible ultimately from the ſenſible ones, if we can ſhew of each intellectual pleaſure and pain in particular, that it takes its riſe from other pleaſures and pains, either ſenſible or intellectual. For thus none of the intellectual pleaſures and pains can be original. But the ſenſible pleaſures and pains are evidently originals. They are therefore the only ones, *i. e.* they are the common ſource from whence all the intellectual pleaſures and pains are ultimately derived.

When I ſay, that the intellectual pleaſures *A* and *B* are deducible from one another, I do not mean, that *A* receives back again from *B* that luſtre which it had conferred upon it; for this would be to argue in a circle; but that whereas both *A* and *B* borrow from a variety of ſources, as well as from each other, they may, and indeed muſt, transfer by aſſociation part of the luſtre borrowed from foreign ſources upon each other.

If we admit the power of aſſociation, and can alſo ſhew, that aſſociations, ſufficient in kind and degree, concur, in fact, in the ſeveral inſtances of our intellectual pleaſures and pains, this will, of itſelf, exclude all other cauſes for theſe pleaſures and pains, ſuch as inſtinct for inſtance. If we cannot trace out aſſociations ſufficient in kind and degree, ſtill it will not be neceſſary to have recourſe to other cauſes, becauſe great allowances are to be made for the novelty, complexneſs, and intricacy of the ſubject. However, on the other hand, analogy may perhaps lead us to conclude, that as inſtinct prevails much, and reaſon a little in brutes, ſo inſtinct ought to prevail a little in us. Let the facts ſpeak for themſelves.

SECT. I.

OF THE PLEASURES AND PAINS OF IMAGINATION.

I BEGIN with the pleaſures and pains of imagination; and ſhall endeavour to derive each ſpecies of them by aſſociation, either from thoſe of ſenſation, ambition, ſelf-intereſt, ſympathy, theopathy, and the moral ſenſe, or from foreign ones of imagination. They may be diſtinguiſhed into the ſeven kinds that follow.

Firſt, The pleaſures ariſing from the beauty of the natural world.

Secondly, Thoſe from the works of art.

Thirdly, From the liberal arts of muſic, painting, and poetry.

Fourthly, from the ſciences.

Fifthly, From the beauty of the perſon.

Sixthly, From wit and humour.

Seventhly, The pains which ariſe from groſs abſurdity, inconſiſtency, or deformity.

PROP. XCIV.

To examine how far the juſt-mentioned Pleaſures and Pains of Imagination are agreeable to the Doctrine of Aſſociation.

Of the PLEASURES ariſing from the BEAUTY of the NATURAL WORLD.

THE pleaſures ariſing from the contemplation of the beauties of the natural world ſeem to admit of the following analyſis.

The pleaſant taſtes, and ſmells, and the fine colours of fruits and flowers, the melody of birds, and the grateful warmth or coolneſs of the air, in the proper ſeaſons, transfer miniatures of theſe pleaſures upon rural ſcenes, which ſtart up inſtantaneouſly ſo mixed with each other, and with ſuch as will be immediately enumerated, as to be ſeparately indiſcernible.

If there be a precipice, a cataract, a mountain of ſnow, &c. in one part of the ſcene, the naſcent ideas of fear and horror magnify and enliven all the other ideas, and by degrees paſs into pleaſures, by ſuggeſting the ſecurity from pain.

In like manner the grandeur of ſome ſcenes, and the novelty of others, by exciting ſurprize and wonder, *i. e.* by making a great difference in the preceding and ſubſequent ſtates of mind, ſo as to border upon, or even enter the limits of pain, may greatly enhance the pleaſure.

Uniformity and variety in conjunction are alſo principal ſources of the pleaſures of beauty, being made ſo partly by their aſſociation with the beauties of nature; partly by that with the works of art; and with the many conveniences which we receive from the uniformity and variety of the works of nature and art. They muſt therefore transfer part of the luſtre borrowed from the works of art, and from the head of convenience, upon the works of nature.

Poetry and painting are much employed in ſetting forth the beauties of the natural world, at the ſame time that they afford us a high degree of pleaſure from many other ſources. Hence the beauties of nature delight poets and painters, and ſuch as are addicted to the ſtudy of their works, more than others. Part of this effect is indeed owing to the greater attention of ſuch perſons to the other ſources; but this comes to the ſame thing, as far as the general theory of the factitious, aſſociated nature of theſe pleaſures is concerned.

The many ſports and paſtimes, which are peculiar to the country, and whoſe ideas and pleaſures are revived by the view of rural ſcenes, in an evaneſcent ſtate, and ſo mixed together as to be ſeparately indiſcernible, do farther augment the pleaſures ſuggeſted by the beauties of nature.

To theſe we may add, the oppoſition between the offenſiveneſs, dangers, and corruption of populous cities, and the health, tranquillity, and innocence, which the actual view, or the mental contemplation, of rural ſcenes introduces; alſo the pleaſures of ſociality and mirth, which are often found in the greateſt perfection in country retirements, the amorous pleaſures, which have many connections with rural ſcenes, and thoſe which the opinions and encomiums of others beget in us, in this, as in other caſes, by means of the contagiouſneſs obſervable in mental diſpoſitions, as well as bodily ones.

Thoſe perſons who have already formed high ideas of the power, knowledge, and goodneſs of the author of nature, with ſuitable affections, generally feel the exalted pleaſures of devotion upon every view and contemplation of his works, either in an explicit and diſtinct manner, or in a more ſecret and implicit one. Hence, part of the general indeterminate pleaſures, here conſidered, is deducible from the pleaſures of theopathy.

We muſt not omit in this place to remind the reader of a remark made above, viz. that green, which is the middle colour of the ſeven primary ones, and conſequently the moſt agreeable to the organ of ſight, is alſo the general colour of the vegetable kingdom, *i. e.* of external nature.

Theſe may be conſidered as ſome of the principal ſources of the beauties of nature to mankind in general.

neral. Inquiſitive and philoſophical perſons have ſome others, ariſing from their peculiar knowledge and ſtudy of natural hiſtory, aſtronomy, and philoſophy, in general. For the profuſion of beauties, uſes, fitneſſes, elegance in minute things, and magnificence in great ones, exceed all bounds of conception, ſurprize, and aſtoniſhment; new ſcenes, and thoſe of unbounded extent, ſeparately conſidered, ever preſenting themſelves to view, the more any one ſtudies and contemplates the works of God.

particular

And, upon the whole, the reader may ſee, that there are ſufficient ſources for all thoſe pleaſures of imagination, which the beauties of nature excite in different perſons; and that the differences which are found in different perſons in this reſpect, are ſufficiently analogous to the differences of their ſituations in life, and of the conſequent aſſociations formed in them.

An attentive perſon may alſo, in viewing or contemplating the beauties of nature, lay hold, as it were, of the remainders and miniatures of many of the particular pleaſures here enumerated, while they recur in a ſeparate ſtate, and before they coaleſce with the general indeterminate aggregate, and thus verify the hiſtory now propoſed.

It is a confirmation of this hiſtory, that an attentive perſon may alſo obſerve great differences in the kind and degree of the reliſh which he has for the beauties of nature in different periods of his life; eſpecially as the kind and degree may be found to agree in the main with this hiſtory.

To the ſame purpoſe we may remark, that theſe pleaſures do not cloy very ſoon, but are of a laſting nature, if compared with the ſenſible ones; ſince this follows naturally from the great variety of their ſources, and the evaneſcent nature of their conſtituent parts.

When a beautiful ſcene is firſt preſented, there is generally great pleaſure from ſurprize, from being ſtruck with objects and circumſtances which we did not expect. This preſently declines; but is abundantly compenſated afterwards by the gradual alternate exaltation of the ſeveral conſtituent parts of the complex pleaſures, which alſo do probably enhance one another. And thus we may take ſeveral reviews of the ſame ſcene, before the pleaſure, which it affords, comes to its *maximum.* After this the pleaſure muſt decline, if we review it often: but if at conſiderable intervals, ſo as that many foreign ſtates of mind intervene, alſo ſo as that new ſources of the pleaſures of this kind be broken up, the pleaſure may recur for many ſucceſſions of nearly the ſame magnitude.

The ſame obſervations hold in reſpect of the pleaſures from the beauties of nature in general, and indeed from all the other ſources, works of art, liberal arts, ſciences, &c. Theſe all ſtrike and ſurpriſe the young mind at firſt, but require a conſiderable time before they come to their *maximum*; after which ſome or other will always be at its *maximum* for a conſiderable time. However, the pleaſures of imagination in general, as well as each particular ſet and individual, muſt decline at laſt from the nature of our frame. In what manner they ought to decline, ſo as to be conſiſtent with our *ſummum bonum*, by yielding, in due time, to more exalted and pure pleaſures, whoſe compoſition they enter, I will endeavour to ſhew hereafter.

Theſe pleaſures are a principal ſource of thoſe which are annexed to the view of uniformity with variety, as above noted, *i. e.* of analogies of various orders; and conſequently are a principal incitement to our tracing out real analogies, and forming artificial ones.

The novel, the grand, and the marvellous, are alſo moſt conſpicuous in the works of nature; and the laſt ſtrikes us particularly in many of the phænomena of nature, by ſeeming to exceed all bounds of credibility, at the ſame time that we are certified by irrefragable evidences of the truth of the facts. The ſatiety which every pleaſure begets in us, after ſome continuance, makes us thirſt perpetually after the grand and novel; and, as it were, graſp at infinity in number and extent: there being a kind of tacit expectation, that the pleaſure will be in proportion to the magnitude and variety of the cauſes, in the ſame manner as we obſerve, in other caſes, the effects to be in ſome degree proportional to their cauſes.

The pleaſures of novelty decline not only in this claſs, but alſo in all the others ſenſible and intellectual, partly from our bodily frame, partly from the intermixture, and conſequent aſſociation of neutral circumſtances (*i. e.* ſuch as afford neither pleaſure nor pain) in their ſucceſſive recurrences.

A diſpoſition to a pleaſurable ſtate is a general attendant upon health, and the integrity of our bodily faculties; and that in ſuch a degree, as that actual pleaſure will ſpring up from moderate incitements, from the tranſient introduction of the aſſociated circumſtances of former pleaſurable ſtates. If the body be indiſpoſed in ſome degree, it is, however, poſſible to force it into a ſtate of pleaſure by the vivid introduction of various and powerful circumſtances; but this unnatural ſtate cannot laſt long; and, if the indiſpoſition to pleaſure be great, it cannot be introduced at all. On the contrary, where the diſpoſition to pleaſure is preternaturally prevalent, as after wine and opium, and in certain morbid caſes, the leaſt hint will excite profuſe joy, leaning chiefly to the pleaſures of imagination, ambition, ſympathy, or devotion, according to the circumſtances.

It is eaſy to ſee how the doctrine of vibrations, which appears to be the only one that admits of permanent ſtates of motion, and diſpoſition to motion, in the brain, ſuits theſe laſt remarks in a peculiar manner.

OF THE BEAUTIES OF THE WORKS OF ART.

The works of art, which afford us the pleaſures of beauty, are chiefly buildings, public and private, religious, civil, and military, with their appendages and ornaments, and machines of the ſeveral kinds, from the great ones employed in war, commerce, and public affairs, ſuch as ſhips, military engines, machines for manufacturing metals, &c. down to clocks, watches, and domeſtic furniture. The ſurvey of theſe things, when perfect in their kinds, affords great pleaſures to the curious; and theſe pleaſures increaſe for a certain time, by being cultivated and gratified, till at laſt they come to their height, decline, and give way to others, as has been already obſerved of the pleaſures ariſing from the beauties of nature.

The chief ſources of the pleaſures, which the forementioned works of art afford, appear to be the following: the beautiful illuminations from gay colours; the reſemblance which the play-things, that pleaſed us when we were children, bear to them; the great regularity and variety obſervable in them; the grandeur and magnificence of ſome, and the neatneſs and elegance of others, and that eſpecially if they be ſmall; the fitneſs to anſwer uſeful ends; their anſwering a multiplicity of theſe by ſimple means, or by analogous complex ones, not exceeding certain limits in complexneſs; the knowledge conveyed in many caſes; the ſtrong aſſociations with religion, death, war, juſtice, power, riches, titles, high birth, entertainments, mirth, &c. faſhion, with the opinions and encomiums of perſons ſuppoſed to be judges; the vain deſire of having a taſte, and of being thought connoiſſeurs and judges, &c. &c.

In architecture there are certain proportions of breadths, lengths, depths, and entire magnitudes, to each other, which are by ſome ſuppoſed to be naturally beautiful, juſt as the ſimple ratios of 1 to 2, 2 to 3, 3 to 4, &c. in muſic, yield ſounds, which are naturally pleaſant to the ear. But it rather ſeems to me, that œconomical convenience firſt determined the ratios of doors, windows, pillars, &c. in a groſs way; and then that the convenience of the artiſts fixed this determination to ſome few exact ratios, as in the proportion between the lengths and breadths of the pillars of the ſeveral orders. Afterwards theſe proportions became aſſociated ſo often with a variety of beauties in coſtly buildings, that they could not but be thought naturally beautiful at laſt. In merely ornamental parts the beauty of the proportions ſeems to ariſe entirely either from faſhion, or from a ſuppoſed reſemblance to ſomething already fixed as a beautiful proportion. It is eaſy from theſe principles to account for the prevalency of different proportions, and general taſtes, in different ages and countries.

Of the PLEASURES *ariſing from* MUSIC, PAINTING, *and* POETRY.

Let us next conſider the three liberal and ſiſter arts of muſic, painting and poetry.

OF MUSIC.

Now, in reſpect of muſic, it is to be obſerved, that the ſimple ſounds of all uniform ſonorous bodies, and particularly the ſingle notes of the ſeveral muſical inſtruments, alſo all the concords, or notes, whoſe vibrations bear to each other the ſimple ratios of 1 to 2, 2 to 3, 3 to 4, &c. ſounded together, or near to each other, may, be conſidered as originally pleaſant to the ear. Diſcords are originally unpleaſant, and therefore, as in other like caſes, may be made uſe of to heighten our pleaſures, by being properly and ſparingly introduced, ſo as to make a ſtrong contraſt. To which if we add the uniformity and variety obſervable in all good muſic, we ſhall have the chief pleaſures affecting children, and young perſons, upon their being firſt accuſtomed to hear muſic.

By degrees the diſcords become leſs and leſs harſh to the ear, and at laſt even pleaſant, at leaſt by their aſſociations with the concords, that go before, or follow them; ſo that more, and alſo more harſh diſcords, are perpetually required to give a reliſh, and keep the ſweetneſs of the concords from cloying. Particular kinds of air and harmony are aſſociated with particular words, affections, and paſſions, and ſo are made to expreſs theſe; beſides which there is often a natural aptitude in the muſic to repreſent the affection, as in quick muſic, and concords, to repreſent mirth. Muſic in general is connected with gaiety, public rejoicings, the amorous pleaſures, riches, high rank, *&c.* or with battles, ſorrow, death, and religious contemplations. There is an ambition to excel in taſte, in performance, and in compoſition, and a difficulty which enhances the pleaſure, *&c. &c.* till, by theſe and ſuch-like ways, the judgments and taſtes of different perſons, in reſpect of muſic, become as different, as we find them to be in fact.

OF PAINTING.

Our pleaſures from pictures are very nearly related to thoſe of imitation, which, as was obſerved above, take up a conſiderable part of our childhood; and the ſeveral play things repreſenting men, houſes, horſes, *&c.* with which children are ſo much delighted, are to be conſidered, both as augmenting and gratifying this taſte in them.

To this it is to added, that as the ideas of ſight are the moſt vivid of all our ideas, and thoſe which are chiefly laid up in the memory as keys and repoſitories to the reſt, pictures, which are ſomething intermediate between the real object and the idea, and therefore in caſes of ſufficient likeneſs more vivid than the idea, cannot but pleaſe us by thus gratifying our deſire of raiſing up a complete idea of an abſent object. This an attentive perſon may obſerve in himſelf in viewing pictures.

The ſurprize and contraſt which ariſe in children, upon their ſeeing perſons and objects preſent in their pictures, which yet they know to be abſent by ſtriking the mind with the impoſſible conception of the ſame thing in two places, are probably the ſources of conſiderable pleaſure to *them*.

To theſe cauſes let us add the gay colours, and fine ornaments, which generally go along with pictures; and we ſhall have the chief ſources of the pleaſures which painting affords to young perſons, and to thoſe who have not yet been much affected with the various incidents of life, and their repreſentations, or acquired a taſte and ſkill in theſe things.

For, after this, the pleaſures ariſing from pictures are quite of another kind, being derived from the ſame ſources as thoſe that belong to the ſcenes, affections and paſſions repreſented, from the poetical deſcriptions of theſe, from the preciſe juſtneſs of the imitation, from ambition, faſhion, the extravagant prices of the works of certain maſters, from aſſociation with the villas and cabinets of the noble, the rich, and the curious, &c. &c.

The nature of the caricatura, burleſque, groteſque, pictureſque, &c. may be underſtood from what is delivered in other parts of this ſection, concerning laughter, wit, humour, the mavellous, abſurd, &c. to which they correſpond.

Painting has a great advantage over verbal deſcription, in reſpect of the vividneſs and number of ideas to be at once excited in the fancy; but its compaſs is, upon the whole, much narrower; and it is alſo confined to one point of time.

The repreſentations of battles, ſtorms, wild beaſts, and other objects of horror, in pictures, pleaſe us peculiarly, partly from the near alliance which the ideas ſuggeſted bear to pain, partly from the ſecret conſciouſneſs of our own ſecurity, and partly becauſe they awaken and agitate the mind ſufficiently to be ſtrongly affected with the other pleaſures, which may then be offered to it.

OF POETRY.

The beauties and excellencies of good poetry are deducible from three ſources. Firſt, The harmony, regularity, and variety of the numbers or metre, and of the rhyme. Secondly, The fitneſs and ſtrength of the words and phraſes. Thirdly, The ſubject matter of the poem, and the invention and judgment exerted by the poet, in regard to his ſubject. And the beauties ariſing from each of theſe are much transferred upon the other two by aſſociation.

That the verſification has of itſelf a conſiderable influence, may be ſeen by putting good poetical paſſages into the order of proſe. And it may be accounted for from what has been already obſerved of uniformity and variety, from the ſmoothneſs and facility with which verſes run over the tongue, from the frequent coincidence of the end of the ſentence, and that of the verſe, at the ſame time that this rule is violated at proper intervals in all varieties, leſt the ear ſhould be tired with too much ſameneſs, from the aſſiſtance which verſification affords to the memory, from ſome faint reſemblance which it bears to muſic, and its frequent aſſociations with it, &c. &c.

The beauties of the diction ariſe chiefly from the figures; and therefore it will be neceſſary here to inquire into the ſources of their beauties.

Now figurative words ſeem to ſtrike and pleaſe us chiefly from that impropriety which appears at firſt ſight, upon their application to the things denoted by them, and from the conſequent heightening of the propriety, as ſoon as it is duly perceived. For when figurative words have recurred ſo often as to excite the ſecondary idea inſtantaneouſly, and without any previous harſhneſs to the imagination, they loſe their peculiar beauty and force; and, in order to recover this, and make ourſelves ſenſible of it, we are obliged to recall the literal ſenſe, and to place the literal and figurative ſenſes cloſe together, that ſo we may firſt be ſenſible of the inconſiſtency, and then be more affected with the union and coaleſcence.

Beſides this, figurative expreſſions illuminate our diſcourſes and writings by transferring the properties, aſſociations, and emotions, belonging to one thing upon another, by augmenting, diminiſhing, &c. and thus, according as the ſubject is ludicrous or grave, they either increaſe our mirth and laughter, or excite in us love, tenderneſs, compaſſion, admiration, indignation, terror, devotion, &c.

When figures are too diſtant, or too obſcure, when they augment or diminiſh too much, we are diſpleaſed; and the principal art in the uſe of figures is, to heighten, as far as the imagination will permit, the greateſt beauty lying upon the confines of what diſguſts by being too remote or bombaſt. And this extreme limit for figurative expreſſions ſhews evidently, that the pleaſure ariſing from them is nearly allied to pain; and their beauty owing to a certain kind and degree of inconſiſtency.

However, as the various figures uſed in ſpeaking and writing have great influences over each other, alter, and are much altered, as to their relative energy, by our paſſions, cuſtoms, opinions, conſtitutions, educations, &c. there can be no fixed ſtandard for determining what is beauty here, or what is the degree of it. Every perſon may find, that his taſte in theſe things receives conſiderable changes in his progreſs through life; and may, by careful obſervation, trace up theſe changes to the aſſociations that have cauſed them. And yet, ſince mankind have a general reſemblance to each other, both in their internal make, and external circumſtances, there will be ſome general agreements about theſe things common to all mankind. The agreements will alſo become perpetually greater, as the perſons under conſideration are ſuppoſed to agree more in their genius, ſtudies, external circumſtances, &c. Hence may be ſeen, in part, the foundation of the general agreements obſervable in critics, concerning the beauties of poetry, as well as that of their particular diſputes and differences.

It may alſo be proper to remark here, that the cuſtom of introducing figures in a copious manner into poetry, together with the tranſpoſitions, ellipſes, ſuperfluities, and high-ſtrained expreſſions, which the laws of the verſification have forced the beſt poets upon, in ſome caſes, have given a ſanction to certain otherwiſe unallowable liberties of expreſſion, and to a moderate degree of obſcurity, and even converted them into beauties. To which it may be added, that a momentary obſcurity is like a diſcord in muſic properly introduced.

The pleaſure which we receive from the matter of the poem, and the invention and judgment of the poet, in this reſpect, ariſes from the things themſelves deſcribed or repreſented. It is neceſſary therefore, that the poet ſhould chooſe ſuch ſcenes as are beautiful, terrible, or otherwiſe ſtrongly affecting, and ſuch characters as excite love, pity, juſt indignation, &c. or rather, that he ſhould preſent us with a proper mixture of all theſe. For, as they will all pleaſe ſingly, ſo a well ordered ſucceſſion of them will much enhance theſe ſeparate pleaſures, by the contraſts, analogies, and coincidences, which this may be made to introduce. In all theſe things the chief art is to copy nature ſo well, and to be ſo exact in all the principal circumſtances relating to actions, paſſions, &c. *i. e.* to real life, that the reader may be inſenſibly betrayed into a half belief of the truth and reality of the ſcene.

Verſes well pronounced affect us much more, than when they merely paſs over the eye, from the imitation of the affections and paſſions repreſented, by the human voice; and ſtill much more, when acted well, and heightened by the proper conjunction of realizing circumſtances.

Since poetry makes uſe of words, which are the principal channel of mutual communication for our thoughts and affections, and has by this means an unlimited compaſs in reſpect of time, place, &c. it muſt, upon the whole, have great advantages over painting.

As the pleaſures of imagination are very prevalent, and much cultivated, during youth; ſo, if we conſider mankind as one great individual, advancing in age perpetually, it ſeems natural to expect, that in the infancy of knowledge, in the early ages of the world, the taſte of mankind would turn much upon the pleaſures of this claſs. And agreeably to this it may be obſerved, that muſic, painting, and poetry, were much admired in ancient times; and the two laſt brought to great perfection. What was the real perfection of the ancient *Grecian* muſic, alſo how far the modern very artificial compoſitions ought to be allowed to excel them, muſt be left to thoſe who are judges of theſe matters.

The beauties of oratory are very nearly allied to thoſe of poetry, ariſing partly from an harmonious flow and cadence of the periods, ſo that uniformity and variety may be properly mixed, partly from the juſtneſs and nervouſneſs of the expreſſions, and partly from the force of the arguments and motives brought together by the invention of the orator, and ſo diſpoſed as to convince the judgment, excite and gain the affections. In both caſes it is very neceſſary, that the reader or hearer ſhould conceive favourably of the deſign and author, in a moral light. Poetry has the advantage of oratory, in reſpect of the ſweetneſs of the numbers, and boldneſs of the figures; but oratory, being a real thing, and one which has great influence in many the moſt important tranſactions, does, by this reality, affect ſome perſons more than poetry; I mean perſons that are mere readers or hearers; for, as to thoſe that are intereſted in the debate, to whom it is a reality, there can be no doubt.

The beauties of hiſtory will eaſily be underſtood from what is ſaid of poetry and oratory.

It is to be obſerved, that poetry, and all fictitious hiſtory, borrow one chief part of their influence from their being imitations of real hiſtory, as this again does from the ſtrong affections and paſſions excited by the events of life, and from the contagiouſneſs of our tempers and diſpoſitions.

The ſame kind of contraſts and coincidences, which, in low and comic things, would be wit or humour, become the brilliant paſſages that affect and ſtrike us moſt eminently in grave poetry, in oratory, and hiſtory.

OF THE PLEASURES ARISING FROM THE STUDY OF THE SCIENCES.

The ſtudy of the ſciences has a great connection with the natural and artificial beauties already conſidered, and receives great luſtre from them in conſequence thereof.

But beſides this, there are many original ſources of pleaſure in the ſtudy of the ſciences: as, Firſt, From the many inſtances of uniformity with variety: Secondly, From the marvellous and ſeemingly impoſſible, which occur in all parts of knowledge: Thirdly, From the great advantages reſpecting human life, which accrue to mankind in general from the purſuit of knowledge, alſo from the honours, riches, &c. which are the rewards conferred upon particular perſons that are eminent: Laſtly, From the numerous connections of truth of all kinds with thoſe moſt amiable and important doctrines, which religion, natural and revealed, teaches us. And when theſe pleaſures, in their ſeveral ſubordinate kinds and degrees, have been ſufficiently aſſociated with the favouite ſtudy, they render it at laſt pleaſant in itſelf, as we uſually term it, *i. e.* theſe ſeveral particular pleaſures coaleſce into a ſingle general one, in which the compounding parts cannot be diſcerned ſeparately from each other, and which conſequently appears to have no relation to its ſeveral compounding parts; unleſs when by a particular attention to, and examination of, what paſſes in our minds, we lay hold of the laſt compounding parts before their entire coaleſcence, or reaſon upon the cauſes of theſe pleaſures, by comparing their growth, and the changes made in them, with the concomitant circumſtances. Thus, if it be obſerved as a general fact, that perſons grow fond of particular ſtudies, remarkably after having received ſome great preſent advantage, or hope of a future one from them, we may reaſonable preſume, that the pleaſure which they take in theſe ſtudies, is in part derived from this ſource, even though it cannot be felt to ariſe from it explicitly.

OF INVENTION.

The copiouſneſs and quickneſs of the invention being principal requiſites for the cultivation of the arts and ſciences with ſucceſs, I will ſay ſomething concerning invention here, my ſubject being now ſufficiently opened for that purpoſe.

Invention then may be defined the art of producing new beauties in works of imagination, and new truths in matters of ſcience. And it ſeems to depend, in both caſes, chiefly upon theſe three things. Firſt, A ſtrong and quick memory: Secondly, An extenſive knowledge in the arts and ſciences; and particularly in thoſe that are contiguous to, or not far diſtant from, that under conſideration: And, Thirdly, The habit of forming and purſuing analogies, the deviations from theſe, and the ſubordinate analogies viſible in many of theſe firſt deviations, &c. &c.

Firſt, A ſtrong and quick memory is neceſſary, that ſo the ideas of the poet or philoſopher may depend upon, and be readily ſuggeſted by, each other.

Secondly, He muſt have a large ſtock of ideas for the purpoſes of figures, illuſtrations, compariſons, arguments, motives, criterions, &c. And it is evident that the ideas taken from ſuch parts of knowledge, as are pretty nearly allied to his particular ſtudy, will be of moſt uſe to him in it.

Thirdly, Analogy will lead him by degrees, in works of fancy, from the beauties of celebrated maſters to others leſs and leſs reſembling theſe, till at laſt he arrives at ſuch as bear no viſible reſemblance. Deviations, and the ſubordinate analogies contained within them, will do this in a much greater degree; and all analogies will inſtruct him how to model properly ſuch entirely new thoughts, as his memory and acquaintance with things have ſuggeſted to him. In ſcience analogy leads on perpetually to new propoſitions; and, being itſelf ſome preſumption of truth, is a guide much preferable to mere imagination.

It may be obſerved, that the trains of viſible ideas, which accompany our thoughts, are the principal fund for invention, both in matters of fancy, and in ſcience.

As invention requires the three things here ſpoken of, ſo, converſely, no perſon who is poſſeſſed of them, and who applies himſelf to any particular ſtudy either of the imaginative or abſtract kind, with ſufficient aſſiduity, can fail for want of invention. And the nature of this faculty ſeems as reconcileable with, and deducible from, the power of aſſociation, and the mechaniſm of the mind here explained, as that of any other.

OF THE BEAUTY OF THE PERSON.

The word *beauty* is applied to the perſon, particularly in the female ſex, in an eminent manner; and the deſires and pleaſures ariſing from beauty, in this ſenſe, may be conſidered as an intermediate ſtep between the groſs ſenſual ones, and thoſe of pure eſteem and benevolence; for they are, in part, deduced from both theſe extremes; they moderate, ſpiritualize, and improve the firſt, and, in the virtuous, are ultimately converted into the laſt.

But they ariſe alſo from many other ſources in their intermediate ſtate, particularly from aſſociations with the ſeveral beauties of nature and art already mentioned, as of gay colours, rural ſcenes, muſic, painting, and poetry; from aſſociations with faſhion, the opinions and encomiums of others, riches, honours, high birth, &c. from vanity and ambition,

bition,

bition, &c. Beſides which, the pleaſure of gratifying a ſtrong deſire, and the pain of diſappointment, are to be conſidered here, as being evidently diſtinguiſhable from all the reſt in ſome caſes.

That part of beauty which ariſes from ſymmetry, may perhaps be ſaid to conſiſt in ſuch proportions of the features of the face, and of the head, trunk, and limbs, to each other, as are intermediate in reſpect of all other proportions, *i. e.* ſuch proportions as would reſult from an eſtimation by an average: one may ſay at leaſt, that theſe proportions would not differ much from perfect ſymmetry.

The deſires excited by the beauty of the perſon increaſe for ſome time, eſpecially if the ſenſible ones are not gratified, and there be alſo a mixture of hope and fear, in relation to the attainment of the affections of the beloved perſon. But they ſometimes decreaſe, like other deſires, from mere want of novelty, after the affections are gained; and muſt always do ſo after gratification. Nevertheleſs, if there be the proper foundation for eſteem and religious affection in each party, mutual love, with the pleaſures ariſing from it, may increaſe upon the whole, the real circumſtances of life affording more than ſufficient opportunity for gaining in one reſpect, what is loſt in another.

The beauty of the air, geſture, motions, and dreſs, has a great connection with the beauty of the perſon, or rather makes a conſiderable part of it, contributing much to the ſum total; and when conſidered ſeparately, receiving much from the other part of the beauties of the perſon. The ſeparate beauty of theſe things ariſes from ſome imitation of a natural or artificial beauty already eſtabliſhed, from faſhion, high birth, riches, &c. or from their being expreſſive of ſome agreeable or amiable quality of mind. The reciprocal influences of our ideas upon each other, and the endleſs variety of their combinations, are eminently conſpicuous in this article; the ſtrength of deſire here rendering the aſſociations, with the ſeveral ſteps previous to the perfect coaleſcence of the ideas aſſociated, more viſible than in moſt other caſes.

OF WIT AND HUMOUR.

I come now to examine the pleaſures of mirth, wit, and humour.

But, Firſt, it will be neceſſary to conſider the cauſes of laughter, and particularly the mental ones.

Now it may be obſerved, that young children do not laugh aloud for ſome months. The firſt occaſion of doing this ſeems to be a ſurprize, which brings on a momentary fear firſt, and then a momentary joy in conſequence of the removal of that fear, agreeably to what may be obſerved of the pleaſures that follow the removal of pain. This may appear probable, inaſmuch as laughter is a naſcent cry, ſtopped of a ſudden; alſo becauſe if the ſame ſurprize, which makes young children laugh, be a very little increaſed, they will cry. It is uſual, by way of diverting young children, and exciting them to laughter, to repeat the ſurprize, as by clapping the hands frequently, reitering a ſudden motion, &c.

This is the original of laughter in children, in general; but the progreſs in each particular is much accelerated, and the occaſions multiplied, by imitation. They learn to laugh, as they learn to talk and walk; and are moſt apt to laugh profuſely, when they ſee others laugh; the common cauſe contributing alſo in a great degree to produce this effect. The ſame thing is evident even in adults; and ſhews us one of the ſources of the ſympathetic affections.

To theſe things it is to be added, that the alternate motions of the cheſt follow the ſame degrees of mental emotion with more and more facility perpetually, ſo that at laſt children (who are likewiſe more exquiſitely ſenſible and irritable than adults) laugh upon every trifling occaſion.

By degrees they learn the power of ſuſpending the actions both of laughing and crying, and aſſociate this power with a variety of ideas, ſuch as thoſe of decency, reſpect, fear, and ſhame: the incidents and objects, which before occaſioned emotion ſufficient to produce laughter, now occaſion little or none, from the tranſmutation of their aſſociations: their new aſſociated pleaſures and pains are of a more ſedate kind, and do not affect them ſo much by ſurprize; and, which is a principal cauſe in reſpect of individuals, their equals laugh leſs, and, by forming them to the ſame model with themſelves, make the diſpoſition to laughter decreaſe ſtill faſter. For whatever can be ſhewn to take place at all in human nature, muſt take place in a much higher degree, than according to the original cauſes, from our great diſpoſition to imitate one another, which has been already explained.

It confirms this account of laughter, that it follows tickling, as noted above, *i. e.* a momentary pain and apprehenſion of pain, with an immediately ſucceeding removal of theſe, and their alternate recurrency; alſo that the ſofter ſex, and all nervous perſons, are much diſpoſed both to laugh and cry profuſely, and to paſs quickly from one ſtate to the other. And it may deſerve to be inquired, how far the profuſe, continued laughter and mirth on one hand, ſorrow, hanging the lip, and crying, on the other, which occur in madneſs, agree with it.

As children learn the uſe of language, they learn alſo to laugh at ſentences or ſtories, by which ſudden alarming emotions and expectations are raiſed in them, and again diſſipated inſtantaneouſly. And as they learnt before by degrees to laugh at ſudden unexpected noiſes, or motions, where there was no fear, or no diſtinguiſhable one, ſo it is after ſome time in reſpect of words. Children, and young perſons, are diverted by every little jingle, pun, contraſt, or coincidence, which is level to their capacities, even though the harſhneſs and inconſiſtency, with which it firſt ſtrikes the fancy, be ſo minute as ſcarce to be perceived. And this is the origin of that laughter, which is excited by wit, humour, buffoonery, &c.

But this ſpecies of laughter abates alſo by degrees, as the other before conſidered did, and, in general, for the ſame cauſes; ſo that adults, and eſpecially thoſe that are judges of politeneſs and propriety, laugh only at ſuch ſtrokes of wit and humour, as ſurprize by ſome more than ordinary degree of contraſt or coincidence; and have at the ſame time a due connection with pleaſure and pain, and their ſeveral aſſociations of fitneſs, decency, inconſiſtency, abſurdity, honour, ſhame, virtue, and vice; ſo as neither to be too glaring on the one hand, nor too faint on the other. In the firſt caſe, the repreſentation raiſes diſlike and abhorrence; in the laſt, it becomes inſipid.

From hence may be ſeen, that in different perſons the occaſions of laughter muſt be as different as their opinions and diſpoſitions; that low ſimilitudes, alluſions, contraſts, and coincidences, applied to grave and ſerious ſubjects, muſt occaſion the moſt profuſe laughter in perſons of light minds; and, converſely, increaſe this levity of mind, and weaken the regard due to things ſacred; that the vices of gluttony, lewdneſs, vain glory, ſelf-conceit, and covetouſneſs, with the concomitant pleaſures and pains, hopes, fears, dangers, &c. when repreſented by indirect circumſtances, and the repreſentation heightened by contraſts and coincidences, muſt be the moſt frequent ſubject of mirth, wit, and humour, in this mixed degenerate ſtate, where they are cenſured upon the whole; and yet not looked upon with a due degree of ſeverity, diſtance, and abhorrence; that company,

pany, feaſting, and wine, by putting the body into a pleaſurable ſtate, muſt diſpoſe to laughter upon ſmall occaſions; and that perſons who give themſelves much to mirth, wit, and humour, muſt thereby greatly diſqualify their underſtandings for the ſearch after truth; inaſmuch as by the perpetual hunting after apparent and partial agreements and diſagreements, as in words, and indirect accidental circumſtances, whilſt the true natures of the things themſelves afford real agreements and diſagreements, that are very different, or quite oppoſite, a man muſt by degrees pervert all his notions of things themſelves, and become unable to ſee them as they really are, and as they appear to conſiderate ſober-minded inquirers. He muſt loſe all his aſſociations of the viſible ideas of things, their names, ſymbols, &c. with their uſeful practical relations and properties; and get, in their ſtead, accidental, indirect, and unnatural conjunctions of circumſtances, that are really foreign to each other, or oppoſitions of thoſe that are united; and, after ſome time, habit and cuſtom will fix theſe upon him.

The moſt natural occaſions of mirth and laughter in adults ſeem to be the little miſtakes and follies of children, and the ſmaller inconſiſtencies and improprieties, which happen in converſation, and the daily occurrences of life; inaſmuch as theſe pleaſures are, in great meaſure, occaſioned, or at leaſt ſupported, by the general pleaſurable ſtate, which our love and affection to our friends in general, and to children in particular, put the body and mind into. For this kind of mirth is always checked where we have a diſlike; alſo where the miſtake or inconſiſtency riſes beyond a certain limit; for then it produces concern, confuſion, and uneaſineſs. And it is uſeful not only in reſpect of the good effects which it has upon the body, and the preſent amuſement and relaxation that it affords to the mind; but alſo, becauſe it puts us upon rectifying what is ſo amiſs, or any other ſimilar error, in one another, or in children; and has a tendency to remove many prejudices from cuſtom and education. Thus we often laugh at children, ruſtics, and foreigners, when yet they act right, according to the truly natural, ſimple, and uncorrupted dictates of reaſon and propriety, and are guilty of no other inconſiſtency, than what ariſes from the uſurpations of cuſtom over nature; and we often take notice of this, and correct ourſelves, in conſequence of being diverted by it.

OF INCONSISTENCY, DEFORMITY, AND ABSURDITY.

Having now conſidered, in a ſhort and general way, all the pleaſures that ſeem properly to belong to the head of imagination, I will ſay ſomething concerning the pains of this claſs, viz. thoſe which ariſe from the view of groſs inconſiſtency, abſurdity, and deformity. Here we may obſerve,

Firſt, That theſe pains are the root and ſource of many of the fore-mentioned pleaſures, particularly thoſe ariſing from figurative expreſſions, and of wit and humour, as has been ſhewn in treating of theſe things.

Secondly, That the diſguſt and uneaſineſs here conſidered never riſe to any very great height, unleſs ſome of the pains of ſympathy, or of the moral ſenſe, mix themſelves with them. From whence it ſeems to follow, that the mere *pleaſures* of imagination and beauty are alſo of a kind much inferior to thoſe of ſympathy, and the moral ſenſe.

The perplexity, confuſion, and uneaſineſs, which we labour under in abſtruſe inquiries, philoſophical, moral, and religious, ought, perhaps, to be referred to this head. Alſo the ſecondary perplexity which ariſes from our being ſubject to this perplexity, confuſion and uneaſineſs. However, all this is to be accounted for as any other evil, and does not ſeem to be attended either with greater or leſs difficulties. No perplexity can give us more than a limited degree of pain; and all our perplexities have probably both the ſame general good effects as our other pains; and alſo, like each of theſe, ſome good effects peculiar to themſelves.

We may now obſerve upon the whole, that according to the foregoing hiſtory of the pleaſures of imagination, there muſt be great differences in the taſtes and judgments of different perſons; and that no age, nation, claſs of men, &c. ought to be made the teſt of what is moſt excellent in artificial beauty; nor conſequently of what is abſurd. The only things that can be ſet up as natural criterions here ſeem to be uniformity with variety, uſefulneſs in general, and the particular ſubſerviency of this or that artificial beauty to improve the mind, ſo as to make it ſuit beſt with our preſent circumſtances, and future expectations. How all theſe criterions conſiſt with each other, and unite in the ſingle criterion of religion, or the love of God, and of our neighbour, underſtood in the comprehenſive ſenſe of theſe words, I ſhall endeavour to ſhew hereafter.

SECT. II.

OF THE PLEASURES AND PAINS OF AMBITION.

PROP. XCV.

To examine how far the Pleaſures and Pains of Ambition are agreeable to the foregoing Theory.

THE opinions of others concerning us, when expreſſed by correſponding words or actions, are principal ſources of happineſs or miſery. The pleaſures of this kind are uſually referred to the head of honour; the pains to that of ſhame; but as it is moſt convenient to have a ſingle word, to which to refer both the pleaſures and pains of this claſs, I have made choice of ambition for that purpoſe. It will therefore be our buſineſs, under this propoſition, to inquire by what aſſociations it is brought about, that men are ſo ſolicitous to have certain particulars concerning themſelves made known to the circle of their friends and acquaintance, or to the world in general; and certain others concealed from them; alſo, why all marks and evidences, that theſe two ſeveral kinds of particulars are made known, ſo as to beget approbation, eſteem, praiſe, high opinion, &c. or diſlike, cenſure, contempt, &c. occaſion ſuch exquiſite pleaſures and pains, as thoſe of honour and ſhame, *i. e.* of ambition.

The particulars which we deſire to have made known to, or concealed from, others, in order to obtain praiſe, or avoid diſpraiſe, may be claſſed under the four following heads.

Firſt, External advantages or diſadvantages.
Secondly, Bodily perfections and imperfections.
Thirdly, Intellectual accompliſhments or defects.
Fourthly, Moral ones, *i. e.* virtue or vice.

I will now endeavour to ſhew what pleaſures and pains, bodily and intellectual, are aſſociated with the opinions which others form of us, in theſe four reſpects, *i. e.* either with the ſeveral methods by which they receive their information; or with thoſe by which they ſignify their having received it, and their conſequent approbation or diſapprobation, reſpect or contempt.

OF EXTERNAL ADVANTAGES AND DISADVANTAGES.

I begin with the conſideration of external advantages or diſadvantages. The principal of theſe are fine clothes, riches, titles, and high birth, with their oppoſites, rags, poverty, obſcurity, and low birth.

Now it is evident, that theſe external advantages and diſadvantages become ſuch by being made known to others; that the firſt gain men certain privileges and pleaſures; and the laſt ſubject them to inconveniencies and evils only, or chiefly, when they are diſcovered to the world. It follows therefore that every diſcovery of this kind to others, alſo every mark and aſſociate of ſuch diſcovery, will, by aſſociation, raiſe up the miniatures of the privileges and pleaſures, inconveniencies, and evils, reſpectively; and thus afford, in each inſtance, a peculiar compound pleaſure or pain, which, by the uſe of language, has the word *honour* or *ſhame* reſpectively annexed to it.

This is the groſs account of the generation of theſe pleaſures and pains; but the ſubordinate particulars contain many things worthy of obſervation.

Thus fine clothes pleaſe both children and adults, by their natural or artificial beauty; they enhance the beauty of the perſon; they excite the compliments and careſſes of the attendants in a peculiarly vivid manner; they are the common aſſociates of riches, titles, and high birth; they have vaſt encomiums beſtowed upon them; and are ſometimes the rewards of mental accompliſhments and virtue. Rags, on the contrary, are often attended with the moſt loathſome and offenſive ideas, with bodily infirmity, poverty, contempt, and vice. It is eaſy therefore to ſee, that in our progreſs through life, a compound aſſociated deſire of fine clothes, and abhorrence of rags, will ſpring up ſo early as to be deemed a natural one. And if a perſon paſſes of a ſudden from rags to fine clothes, or *vice verſa*, the pleaſure or pain will be enhanced accordingly, by the juxtapoſition of the oppoſites.

Now theſe pleaſures and pains, which thus attend a perſon's being actually dreſſed in fine clothes, or in rags, will, by farther aſſociations, be transferred upon all the concomitant circumſtances, the poſſeſſion of fine clothes, the hopes of them, or the fear of rags; and particularly upon all narrations and ſymbols, whereby others are firſt informed of the perſon's dreſs, or diſcover their prior knowledge of it; ſo that the perſon ſhall have his vanity gratified, or his ſhame excited, by all ſuch narrations, and by all the concomitant circumſtances and ſymbols.

Riches, titles, and high birth, are attended with aſſociates of the ſame kind as fine clothes; with this difference, however, that it requires a farther progreſs in life to be ſufficiently affected with the compound pleaſure reſulting from the aſſociates of theſe, and conſequently for acquiring a taſte for thoſe pleaſures of honour, which riches, titles, and high birth afford. Agreeably to which it may be obſerved, that the firſt inſtance of pride and vanity in children is that which ariſes from fine clothes.

In the progreſs through life, eſpecially in the virtuous, it often happens, that oppoſite aſſociations are generated, *i. e.* ſuch as break the connection between the ideas of happineſs and fine clothes, riches, titles, high birth; alſo between miſery and rags, poverty, obſcurity, and low birth; nay, there are ſome inſtances in which theſe laſt are connected with ſome kinds and degrees of happineſs. Now in all theſe caſes the pride and vanity, or ſhame, by which we hope or fear to have our circumſtances, in theſe reſpects, known to the world, leſſen, ceaſe entirely, or even turn about to the oppoſite quarter accordingly; ſo that when a perſon has loſt his deſire of being rich, or high born, he alſo loſes his deſire of being thought ſo; and when he gains an oppoſite deſire of becoming poor, on a religious account, for inſtance, or a complacence in being low born, on account of his preſent high ſtation, &c. he deſires alſo to have this known to the world And yet there may, in moſt caſes, be perceived ſome diſtance in time between the deſire of *being*, and the ſubſequent aſſociated deſire of *being thought*, viz. ſuch a diſtance of time as may ſuffice for the aſſociations to produce their effect in.

Riches are attended with many conveniencies, whether a perſon be known to poſſeſs them, or no; and there are inconveniencies, as well as conveniencies, attending the reputation of being rich; but titles and high birth are then only productive of privileges and pleaſures, when made known to the world; whence it is eaſy to ſee that pride and vanity may ſhew themſelves much more commonly in reſpect of titles and high birth than in reſpect of riches, which is agreeable to the fact.

The ſhamefacedneſs of ruſtics, poor perſons, and inferiors, in general, in the preſence of their ſuperiors, with the great confuſion and uneaſineſs that often attend it, ariſes from the ſources [illegible]nour and ſhame here laid open, and particularly from the ſtrong contraſt between their own circumſtances and thoſe of their ſuperiors.

OF BODILY PERFECTIONS AND IMPERFECTIONS.

The chief bodily circumſtances, which are the ſources of the pleaſures of honour, or of the pains of ſhame, are beauty, ſtrength, and health, on the one hand; and their oppoſites, deformity, imbecility, unfitting a perſon for the functions of life, and diſeaſe, on the other. I will make ſome ſhort remarks upon each.

Beauty has an intimate connection with one of the moſt violent of our deſires; affords a great pleaſure, even when this deſire is not felt explicitly; has the higheſt encomiums beſtowed upon it in books, eſpecially in ſuch as are too much in the hands of young perſons, and the higheſt compliments paid to it in diſcourſe; and is often the occaſion of ſucceſs in life; all which holds more particularly in reſpect of women, than of men. No wonder therefore, that both ſexes, but eſpecially women, ſhould deſire both to *be* and *be thought* beautiful, and be pleaſed with all the aſſociated circumſtances of theſe things; and that the fear of *being* or *being thought* deformed, ſhould be a thing to which the imagination has the greateſt reluctance. And the reputation of beauty, with the ſcandal of deformity, influences ſo much the more, as beauty and deformity are not attended with their reſpective pleaſing or diſpleaſing aſſociates, except when they are made apparent to, and taken [illegible]otice of by the world. So that here the original [illegible]ſire is rather to *be thought* beautiful than to *be* ſo; [illegible]d this laſt is chiefly a conſequential one ariſing in [illegible] minds, from the cloſe connection of *being* with [illegible]*ng thought*.

In ſtrength it is otherwiſe. This is the ſource of many conveniencies, and imbecility, its oppoſite, of many inconveniencies, whether they be taken notice of or no; as well as of ſome which depend on their being thus taken notice of. It is reaſonable therefore here to ſuppoſe, that our firſt and greateſt deſire ſhould be after the thing itſelf; and ſo it is in fact. However, ſince ſeveral advantages ariſe from ſhewing our ſtrength; ſince alſo the oſtentation of happineſs of any kind belonging to ourſelves, or the notice which others take of it, bring in the pleaſing idea with great vigour; it is evident that there muſt be eager deſires of *being thought* ſtrong, agile, &c. as well as of *being* ſo. And, by parity of reaſon, men will be much aſhamed of *being thought* weak and feeble, as well as afraid of being ſo. And as women glory chiefly in beauty, ſo men do in ſtrength; this being chiefly a ſource of advantages and pleaſures to men, as that is to women. Nay, one may even obſerve, that any great degree of beauty in men, or ſtrength in women, by being oppoſite to that perfection, which is peculiar to each ſex, is thought rather undeſirable than deſirable.

Health and ſickneſs have many connections with beauty and ſtrength, deformity and imbecility, reſpectively; and therefore may eaſily be conceived to become reſpectively the ſources of the pleaſures of honour, or of the pains of ſhame, agreeably to the fact. But, in diſeaſes, ſo many greater pains and evils, fears, anxieties, &c. with ſome pleaſures, ſuch as thoſe of friendſhip, occur likewiſe, that there is, in moſt caſes, little room for ſhame to exert itſelf: however, if the diſeaſe be the conſequence either of a virtuous, or a vicious, courſe of action, the honour or ſhame, belonging to virtue or vice reſpectively, will be transferred upon it.

There is an high degree of ſhame, which attends the natural evacuations, particularly thoſe of the fæces and urine, which is in part deduced from the offenſiveneſs of the excrements of the body, and is nearly related to the ſhame attending bodily infirmities and diſeaſes. But this ſhame, as it reſpects the fæces and urine, has alſo a particular connection with that which relates to the pudenda, ariſing from the vicinity of the organs; and thus they give and receive mutually. They are alſo both of them much increaſed by education, cuſtom, and the precepts and epithets of parents and governors. The original ſources of the ſhame relating to the pudenda are probably the privacy requiſite (which is both cauſe and effect), the greatneſs of the pleaſure, and the ſenſe of guilt which often attends; and there may be perhaps ſomething of inſtinct, which operates here quite independently of aſſociation.

OF INTELLECTUAL ACCOMPLISHMENTS AND DEFECTS.

The intellectual accompliſhments and defects which occaſion honour and ſhame, are ſagacity, memory, invention, wit, learning; and their oppoſites, folly, dulneſs, and ignorance. Here we may deduce a conſiderable part from the many advantages ariſing from the accompliſhments, diſadvantages from the defects, in the ſame manner as has been done already in the two foregoing articles. But a great part, perhaps the greateſt, is deduced from the high-ſtrained encomiums, applauſes, and flatteries, paid to parts and learning, and the outrageous ridicule and contempt thrown upon folly and ignorance, in all the diſcourſes and writings of men of genius and learning; theſe perſons being extremely partial to their own excellencies, and carrying the world with them by the force of their parts and eloquence. It is alſo to be obſerved, that in the education of young perſons, and eſpecially of boys and young men, great rewards are conferred in conſequence of intellectual attainments and parts; and great puniſhments follow negligence and ignorance; which rewards and puniſhments, being reſpectively aſſociated with the words expreſſing praiſe and cenſure, and with all their other circumſtances, transfer upon praiſe and cenſure compound vivid miniatures, pleaſant and painful.

In like manner all the kinds of honour and ſhame, by being expreſſed in words and ſymbols, that are nearly related to each other, enhance each other: thus, for inſtance, the careſſes given to a child when he is dreſſed in fine clothes prepare him to be much more affected with the careſſes and encomiums beſtowed upon him when he has been diligent in getting his leſſon, and indeed it ought to be remarked, that the words and phraſes of the parents, governors, ſuperiors, and attendants, have ſo great an influence over children, when they firſt come to the uſe of language, as inſtantly to generate an implicit belief, a ſtrong deſire, or a high degree of pleaſure. They have no ſuſpicions, jealouſies, memories, or expectations of being deceived or diſappointed; and therefore a ſet of words expreſſing pleaſures of any kind, which they have experienced, put together in almoſt any manner, will raiſe up in them a pleaſurable ſtate, and oppoſite words a painful one. Whence it is eaſy to ſee, that the fine language expreſſing praiſe, and the harſh one expreſſing diſpraiſe, muſt inſtantly, from the mere aſſociations heaped upon the ſeparate words, put them into a ſtate of hope and joy, fear and ſorrow, reſpectively. And when the foundation is thus laid, praiſe and diſpraiſe will keep their influences from the advantages and diſadvantages attending them, though the ſeparate words ſhould loſe their particular influences, as they manifeſtly do in our progreſs through life.

The honour and ſhame ariſing from intellectual accompliſhments do often, in learned men, after ſome time, deſtroy, in great meaſure, their ſenſibility, in reſpect of every other kind of honour and ſhame; which ſeems chiefly to ariſe from their converſing much with books, and learned men, ſo as to have a great part of the pleaſures, which they receive from this their converſation, cloſely connected with the encomiums upon parts and learning, alſo to have all terms of honour applied to them, and the keeneſt reproach, and moſt inſolent contempt, caſt upon the contrary defects. And, as the pleaſures which raillery, ridicule, and ſatire, afford to the by-ſtanders, are very conſiderable, ſo the perſon who is the object of them, and who begins to be in pain upon the firſt ſlight marks of contempt, has this pain much enhanced by the contraſt, the exquiſiteneſs of [illegible] uneaſineſs and confuſion riſing in proportion to the degree of mirth, and inſolent laughter in the by-ſtanders; whence it comes to paſs, that extremely few perſons have courage to ſtand the force of ridicule but rather ſubject themſelves to conſiderable bodily pains, to loſſes, and to the anxiety of a guilty mind, than appear fooliſh, abſurd, ſingular, or contemptible to the world, or even to perſons of whoſe judgment and abilities they have a low opinion.

All this is, in general, more applicable to men than to women, juſt as the honour and ſhame belonging to beauty and deformity is more applicable to women than men; both which obſervations are eaſily deducible from the different talents and ſituations in life of the two ſexes.

OF VIRTUE AND VICE.

We come, in the laſt place, to conſider moral accompliſhments and defects, or virtue and vice. Now it is very evident, that the many advantages, public and private, which ariſe from the firſt, will engage the world to beſtow upon it much honour and applauſe, in the ſame manner as the evil conſequences of vice muſt make *it* the object of cenſure and reproach. Since therefore the child is affected with the words expreſſing honour and cenſure, both from the ſeparate influences of theſe words, and from the application of phraſes of this kind to other ſubjects of praiſe and diſpraiſe, he muſt be affected by the commendations beſtowed upon him when he has done well, and by the cenſures paſſed on him when he has done ill.

Theſe commendations and cenſures are alſo attended with great immediate rewards and puniſhments, likewiſe with the hopes and fears relating to another world; and when the moral ſenſe is ſufficiently generated, with great ſecret indeterminate pleaſure or pain of this kind; and theſe aſſociations add a particular force to the honour and ſhame belonging reſpectively to virtue and vice. At the ſame time it is eaſy to ſee, that ſome conſiderable progreſs in life is ordinarily required before men come to be deeply and laſtingly affected by theſe things; alſo that this kind of honour and ſhame may, at laſt, from the ſuperior force of the aſſociated pleaſures and pains, abſorb, as it were, all the other kinds. A religious man becomes at laſt inſenſible, in great meaſure, to every encomium and reproach, excepting ſuch as he apprehends will reſt upon him at the laſt day, from him whoſe judgment cannot err.

This is the general account of the honour and ſhame paid to virtue and vice reſpectively. I will now make a few ſhort ſtrictures upon ſome of the principal virtues and vices.

Firſt, then, Piety is not in general, and amongſt the bulk of mankind, had in great honour. This proceeds from ſeveral cauſes; as that in the order of our progreſs it is the laſt of the virtues, and therefore, having few votaries, it muſt have few advocates; that in the firſt attempts to attain it, men often fall into great degrees of enthuſiaſm and ſuperſtition, and ſo expoſe themſelves to the charges of folly, madneſs, and ſelf-conceit; and that pretences to it are often made uſe of by hypocrites to cover the worſt deſigns. Now from theſe and ſuch like cauſes it happens, that men are much aſhamed to be thought devout, fearing that exquiſite uneaſineſs, which being ridiculed and contemned as fools, madmen, and hypocrites, occaſions. At the ſame time it appears, that amongſt thoſe who have made conſiderable advances in religion, piety will be had in the greateſt honour: theſe ſee evidently how it may be diſtinguiſhed from enthuſiaſm, ſuperſtition, and hypocriſy; and are very little ſolicitous concerning the opinions of the profane world, who are apt to confound them; and therefore as far as their piety will permit any foreign deſire to ariſe, they have an exquiſite reliſh for the honour and eſteem proceeding from the reputation of piety.

Benevolence ſprings up more early in life than piety, and has at firſt view a more immediate good influence upon ſociety. There are alſo greater numbers who arrive at ſome imperfect degrees of it, than who arrive at like degrees of piety; neither are the degenerations and counterfeits of benevolence ſo common as thoſe of piety. On theſe accounts much greater and more frequent encomiums are beſtowed upon it by the bulk of mankind, than upon piety; and theſe with the many advantages reſulting from the reputation of being benevolent, make moſt perſons eagerly deſire this reputation; ſo that they perform many actions from mere ambition, or from a mixture of this with benevolence, which they deſire the world ſhould think to proceed from mere benevolence.

Military glory, and the high applauſes beſtowed upon perſonal courage, ſeem, in a conſiderable degree, deducible from this ſource, from the benevolent deſign of protecting the innocent, the helpleſs, one's friends and country, from invaſions, robberies, wild beaſts, &c. The connection of theſe with bodily ſtrength, and the characteriſtical perfections of men as diſtinguiſhed from women and children, the rarity and difficulty of them, the vaſt encomiums beſtowed upon them by poets, orators and hiſtorians, eſpecially in ancient times, *i. e.* by thoſe authors which are read in ſchools, and lay hold of our pliant imaginations when young, the ridicule caſt upon timorouſneſs of boys and men, as not being a common imperfection amongſt them, and the connection of the fear of death with the ſenſe of guilt, all concur likewiſe, and have carried mankind ſo far as make them confer the higheſt honours upon the moſt cruel, lawleſs, and abominable actions, and conſequently incite one another to perform ſuch actions from ambitious views. However, this falſe glare ſeems to fade in theory, amongſt writers; and one may hope that the practice of mankind will be, in ſome meaſure, agreeable to the corrections made in their theory.

Temperance and chaſtity have conſiderable honours beſtowed upon them; but the ſhame and ſcandal attending the oppoſite vices, and which ariſe from the loathſome diſeaſes, and the many miſeries, which men bring upon themſelves and others by theſe vices, are much more remarkable. The detail of theſe things might eaſily be delivered from parallel obſervations already made. It happens ſometimes, that ſome degrees of theſe vices are looked upon by young and ignorant perſons, as honourable, from certain connections with manlineſs, faſhion, high life: however, this is ſtill in conformity with the doctrine of aſſociation, and the derivation of all the pleaſures of honour from happineſs under ſome form or other; and, when the ſame perſons become better inſtructed in the real conſequences and connections of things, their opinions change accordingly.

Negative humility, or the not thinking better, or more highly, of ourſelves than we ought, in reſpect of external advantages, bodily, intellectual, or moral accompliſhments, and being content with ſuch regards as are our due, which is the firſt ſtep; and then poſitive humility, or a deep ſenſe of our own miſery and imperfections of all kinds, and an acquieſcence in the treatment which we receive from others, whatever it be; being virtues which are moſt commodious to ourſelves and others, and highly amiable in the ſight of all thoſe who have made a due proficiency in religion, and the moral ſenſe, come at laſt to be honoured and eſteemed in an eminent manner, and conſequently to incite men from mere vanity and ambition to ſeek the praiſe of humility. And the ridicule and ſhame which attend vanity, pride, and ſelf-conceit, concur to the ſame purpoſe; which is a remarkable inſtance of the inconſiſtency of one part of our frame with itſelf, as the caſe now ſtands, and of the tendency of vice to check and deſtroy itſelf.

From the whole of what has been delivered upon this claſs of pleaſures and pains, one may draw the following corollaries.

Cor. 1. All the things in which men pride themſelves, and for which they deſire to be taken notice of by others, are either means of happineſs, or have ſome near relation to it. And indeed it is not at all uncommon to ſee perſons take pains to make others believe, that they are happy, by affirming it in expreſs terms. Now this, conſidered as a mere matter of fact, occurring to attentive obſervation, might lead one to conclude, that the pleaſures of honour and ambition are not of an original, inſtinctive, implanted nature, but derived from the other pleaſures of human life, by the aſſociation of theſe into various parcels, where the ſeveral ingredients are ſo mixed amongſt one another, as hardly to be diſcernible ſeparately.

The young, the gay, and the polite, are ambitious of being thought beautiful, rich, high born, witty, &c. The grave, the learned, the afflicted, the religious, &c. ſeek the praiſe of wiſdom and knowledge, or to be eſteemed for piety and charity; every one according to his opinions of theſe things, as the ſources, marks, or offſprings of happineſs. And when men boaſt of their poverty, low birth, ignorance, or vice, it is always in ſuch circumſtances, with ſuch additions and contraſts, or under ſuch reſtrictions, as that the balance, upon the whole, may, ſome way or other, be the more in their favour on that account.

Cor. 2. Praiſe and ſhame are made uſe of by parents and governors, as chief motives and ſprings of action; and it becomes matter of praiſe to a child, to be influenced by praiſe, and deterred by ſhame; and matter of reproach, to be inſenſible in theſe reſpects. And thus it comes to paſs, that praiſe and ſhame have a ſtrong reflected influence upon themſelves; and that praiſe begets the love of praiſe, and ſhame increaſes the fear of ſhame. Now, though the original praiſe, commendation, blame, cenſure, &c. of good parents and preceptors, extend only, for the moſt part, to acquired accompliſhments and defects, and particularly to virtue and vice; yet the ſecondary influence will affect men in reſpect of all ſorts of encomiums and cenſures, of every thing that comes under the ſame denomination, that is aſſociated with, or tied up by, the ſame words. Though the preceptor direct his pupil only to regard the judgment of the wiſe and good, ſtill there are ſo many like circumſtances attending the judgment of others, that it will be regarded ſomething the more from the leſſons received, in reſpect of the wiſe and good, excluſively of others.

Cor. 3. In conſidering the ſources of honour and ſhame it will appear, that they are by no means conſiſtent with one another; and, by a farther inquiry, that the *maximum* of the pleaſures of this claſs ultimately coincides, *omni ex parte*, with moral rectitude.

SECT. III.

OF THE PLEASURES AND PAINS OF SELF-INTEREST.

PROP. XCVI.

To examine how far the Pleaſures and Pains of Self-intereſt are agreeable to the foregoing Theory.

SELF-INTEREST may be diſtinguiſhed into three kinds, viz.

Firſt, Groſs ſelf-intereſt, or the cool purſuit of the means whereby the pleaſures of ſenſation, imagination, and ambition, are to be obtained, and their pains avoided.

Secondly, Refined ſelf-intereſt, or a like purſuit of the means that relate to the pleaſures and pains of ſympathy, theopathy, and the moral ſenſe.

And, Thirdly, Rational ſelf-intereſt, or the purſuit of a man's greateſt poſſible happineſs, without any partiality to this or that kind of happineſs, means of happineſs, means of a means, &c.

OF GROSS SELF-INTEREST.

The love of money may be conſidered as the chief ſpecies of groſs ſelf-intereſt, and will help us, in an eminent manner, to unfold the mutual influences of our pleaſures and pains, with the factitious nature of the intellectual ones, and the doctrine of aſſociation in general, as well as the particular progreſs, windings, and endleſs redoublings of ſelf-love. For it is evident at firſt ſight, that money cannot naturally and originally be the object of our faculties; no child can be ſuppoſed born with the love of it. Yet we ſee, that ſome ſmall degrees of this love riſe early in infancy; that it generally increaſes during youth and manhood; and that at laſt, in ſome old perſons, it ſo engroſſes and abſorbs all their paſſions and purſuits, as that from being conſidered as the repreſentative, ſtandard, common meaſure and means of obtaining the commodities which occur in common life, it ſhall be eſteemed the adequate exponent and means of happineſs in general, and the thing itſelf, the ſum total of all that is deſirable in life. Now the monſtrous and gigantic ſize of this paſſion, in ſuch caſes, ſupported evidently by aſſociation alone, will render its progreſs and growth more conſpicuous and ſtriking; and conſequently greatly contribute to explain the correſponding particulars in other paſſions, where they are leſs obvious.

Let us inquire therefore, for what reaſons it is that children firſt begin to love money. Now they obſerve, that money procures for them the pleaſures of ſenſation, with ſuch of imagination as they have acquired a reliſh for. They ſee that it is highly valued by others; that thoſe who poſſeſs it are much regarded and careſſed: that the poſſeſſion of it is generally attended by fine clothes, titles, magnificent buildings, &c. Imitation, and the common contagion of human life, having great power here, as in other caſes. Since therefore ideas exciting deſire are thus heaped upon money by ſucceſſive aſſociations perpetually recurring, the deſire of it in certain ſums and manners, viz. ſuch as have often recurred with the concomitant pleaſures, muſt at laſt grow ſtronger than the fainter ſenſible and intellectual pleaſures; ſo that a child ſhall prefer a piece of money to many actual gratifications to be enjoyed immediately.

And as all the fore-mentioned aſſociations, or ſuch as are analogous to them, continue during life, it ſeems probable, that the love of money would at laſt devour all the particular deſires, upon which it is grounded, was it not reſtrained by counter-aſſociations; juſt as it was obſerved above, that the pleaſure of gratifying the will would devour all the particular pleaſures, to which it is a conſtant aſſociate, did not repeated diſappointments preſerve us from this enormous increaſe of wilfulneſs.

Let us next examine how the love of money is checked.

Firſt, then, It is checked by the ſtrong deſires of young perſons, and others, after particular gratifications; for theſe deſires, by overpowering their acquired averſion to part with money, weaken it gradually, and conſequently weaken the pleaſure of keeping, and the deſire of obtaining, all which are cloſely linked together in this view; notwithſtanding that the laſt, viz. the deſire of obtaining, and by conſequence (in an inverted order) the pleaſure of keeping, and the averſion to part with, are ſtrengthened by the deſires of particular pleaſures to be purchaſed by money, in another view. And this contrariety of our aſſociations is not only the means of limiting certain paſſions, but is a mark ſet upon them by the author of nature, to ſhew that they ought to be limited, even in our progreſs through this life; and that they muſt ultimately be annihilated, every one in its proper order.

Secondly, The inſignificancy of riches in warding off death and diſeaſes, alſo ſhame and contempt in many caſes, and in obtaining the pleaſures of religion, and the moral ſenſe, and even thoſe of ſympathy, ambition, imagination, and ſenſation, firſt leſſen their value in the eyes of thoſe who make juſt obſervations upon things in their progreſs through life, and afterwards fix a poſitive nothingneſs and worthleſſneſs upon them.

Thirdly, The eager purſuit of any particular end, as fame, learning, the pleaſures of the imagination, &c. leaves little room in the mind either for avarice, or any other foreign end.

Now by theſe and ſuch like conſiderations we may account not only for the limitation put to the love of money, but alſo for certain mixtures of tempers and diſpoſitions, which are often found in fact, and yet ſeem at firſt ſight inconſiſtent ones. Thus profuſeneſs in reſpect of ſenſual and ſelfiſh pleaſures is often joined with avarice. Covetous perſons are often rigidly juſt in paying, as well as exacting; and ſometimes generous, where money is not immediately and apparently concerned. They have alſo moderate paſſions in other reſpects; for the moſt part, are ſuſpicious, timorous, and complaiſant. And the moſt truly generous, charitable, and pious perſons, are highly frugal, ſo as to put on the appearance of covetouſneſs, and even ſometimes, and in ſome things, to border upon it.

We may ſee alſo, why the love of money muſt in general, grow ſtronger with age; and eſpecially if the particular gratifications, to which the perſon was moſt inclined, become inſipid or unattainable—Why frequent reflections upon money in poſſeſſion, and the actual viewing large ſums, ſtrengthen the aſſociations by which covetouſneſs is generated—Why children, perſons in private and low life, and indeed moſt others, are differently affected towards the ſame ſum of money, in different forms, gold, ſilver, notes, &c.

Let us next inquire, for what reaſons it is that the love of money has the idea of ſelfiſhneſs attached to it in a peculiar manner, much more ſo than the purſuit of the pleaſures of honour, imagination, or ſympathy; whereas all are equally generated by aſſociation, from ſenſible and ſelfiſh pleaſures, all in their ſeveral degrees promote private happineſs, and are all purſued, in ſome caſes, coolly and deliberately from the proſpect of obtaining private happineſs thereby. Now the reaſons of this ſeem to be,

Firſt, That whatever riches one man obtains, another muſt loſe; ſo that the circulation of money by trades, profeſſions, offices, &c. is a kind of gaming; and has moſt of the ſame diſguſtful ideas annexed to it, when conſidered with ſome attention, and excluſively of private ſelfiſh feelings; whereas the pleaſures of ſympathy conſiſt in doing good to others; thoſe of ambition are ſcarce attainable in any great degree without this, or at leaſt the appearance of it; and the pleaſures of imagination are both capable of a very extenſive communication, and moſt perfect when enjoyed in company.

Secondly, A regard to *ſelf* frequently recurring muſt denominate a pleaſure *ſelfiſh*; ſo that if any of the moſt generous pleaſures, and ſuch as at firſt view have no immediate relation to ſelf-intereſt, be purſued in a cool, deliberate way, not from the influence of a preſent inclination, but the preconceived opinion, that it will afford pleaſure, this is referred to ſelf-intereſt. Now money has ſcarce any other relation to pleaſure than that of an evident means; ſo that even after it has gained the power of pleaſing inſtantaneouſly, the intermediate deliberate ſteps and aſſociations muſt, however, frequently appear. It procures the other pleaſures for us every day, after it has become pleaſant in itſelf; and therefore muſt always be conſidered as a principal means. The other pleaſures have, in general, a far greater ſhare of indirect aſſociations with previous pleaſures, and acquire the power of gratifying, not ſo much from being manifeſt cauſes of other gratifications, as their moſt common adjuncts; whereas money is generally the moſt viſible of all the cauſes. But honour, power, learning, and many other things, are purſued, in part, after the ſame manner, and for the ſame reaſons, as riches, viz. from a tacit ſuppoſition, that the acquiſition of every degree of theſe is treaſuring up a proportional degree of happineſs, to be produced and enjoyed at pleaſure. And the deſires of each of theſe would in like manner increaſe perpetually during life, did they not curb one another by many mutual inconſiſtencies, or were not all damped by the frequent experience and recollection, that all the means of happineſs ceaſe to be ſo, when the body or mind ceaſe to be diſpoſed in a manner proper for the reception of happineſs.

It is alſo worthy of obſervation, that riches, honours, power, learning, and all other things, that are conſidered as means of happineſs, become means and ends to each other in a great variety of ways, thus transferring upon each other all the aſſociated pleaſures which they collect from different quarters, and approaching nearer and nearer perpetually to a perfect ſimilarity and ſameneſs with each other, in the inſtantaneous pleaſures which they afford when purſued and obtained as ends.

It appears likewiſe, that all aggregates of pleaſure, thus collected by them all, muſt, from the mechaniſm and neceſſity of our natures, and of the world which ſurrounds us, be made at laſt to centre and reſt upon him who is the inexhauſtible fountain of all power, knowledge, goodneſs, majeſty, glory, property, &c. So that even avarice and ambition are, in their reſpective ways, carrying on the benevolent deſigns of him who is *all in all.* And the ſame thing may be hoped of every other paſſion and purſuit. One may hope, that they all agree and unite in leading to ultimate happineſs and perfection. However, they differ greatly in their preſent conſequences, and in their future ones, reaching to certain intervals of time indefinite and unknown to us, thus becoming good or evil, both naturally and morally, in reſpect of us, and our limited apprehenſions, judgments, and anticipations.

ticipations. And yet one may humbly hope, as was ſaid above, that every thing muſt be ultimately good, both naturally and morally.

OF REFINED SELF-INTEREST.

The ſecond ſpecies of ſelf-intereſt is that which I call refined ſelf-intereſt. As the foregoing ſpecies is generated by an attention to, and frequent reflection upon, the things which procure us the pleaſures of ſenſation, imagination, and ambition; and therefore cannot prevail in any great degree, till theſe pleaſures have been generated, and prevailed for ſome time; ſo this ſpecies, or refined ſelf-intereſt, which is a cool, deliberate ſeeking for ourſelves the pleaſures of ſympathy, religion, and the moral ſenſe, preſuppoſes the generation of theſe pleaſures, and the enjoyment of them for a ſufficient time. And as ſome degree of groſs ſelf-intereſt is the natural and neceſſary conſequence of the three firſt claſſes of pleaſures, ſo is ſome degree of refined ſelf-intereſt of the three laſt. A perſon who has had a ſufficient experience of the pleaſures of friendſhip, generoſity, devotion, and ſelf-approbation, cannot but deſire to have a return of them, when he is not under the particular influence of any one of them, but merely on account of the pleaſure which they have afforded; and will ſeek to excite theſe pleaſures by the uſual means, to treaſure up to himſelf ſuch means, keep himſelf always in a diſpoſition to uſe them, &c. not at all from any particular vivid love of his neighbour, or of God, or from a ſenſe of duty to him, but entirely from the view of private happineſs. At leaſt, there will be a great mixture of this refined ſelf-intereſt in all the pleaſures and duties of benevolence, piety, and the moral ſenſe.

But then this refined ſelf-intereſt is neither ſo common, nor ſo conſpicuous in real life, as the groſs one, ſince it riſes late, is never of any great magnitude in the bulk of mankind, through their want of the previous pleaſures of ſympathy, religion, and the moral ſenſe, in a ſufficient degree, and in ſome it ſcarce prevails at all; whereas groſs ſelf-intereſt riſes early in infancy, and arrives at a conſiderable magnitude before adult age. The detail of this ſecond ſpecies of ſelf-intereſt may be ſeen in books of practical religion.

OF RATIONAL SELF-INTEREST.

The third ſpecies of ſelf-intereſt is the rational. This is the ſame thing with the abſtract deſire of happineſs, and averſion to miſery, which is ſuppoſed to attend every intelligent being during the whole courſe of his exiſtence. I have already endeavoured to ſhew, that this ſuppoſition is not true in the proper ſenſe of the words; and yet that very general deſires do frequently recur to the mind, and may be excited by words and ſymbols of general import.

The hopes and fears relating to a future ſtate, or to death, which is our entrance into it, are of this kind, and may be conſidered as proceeding from rational ſelf-intereſt, in the higheſt and moſt abſtracted ſenſe that the terms admit of practically, ſince we have no definite knowledge of the nature and kind of the happineſs or miſery of another world. Theſe hopes and fears are alſo the ſtrongeſt of our ſelfiſh affections, and yet at the ſame time the chief foundation of the pure diſintereſted love of God, and of our neighbour, and the principal means of transferring our aſſociations, ſo as that we may love and hate, purſue and fly, in the manner the beſt ſuited to our attainment of our greateſt poſſible happineſs. For hope, being itſelf a pleaſure, may, by aſſociation, render indifferent, and even diſagreeable, objects and actions, pleaſant; and fear may make agreeable ones painful: hence we can either increaſe deſires and averſions, that are ſuitable to our ſtate, or obliterate and convert them into their contraries, if they be unſuitable, by means of their connection with the hopes and fears of death, and a future ſtate. I will therefore briefly ſtate the riſe and progreſs of theſe hopes and fears.

All our firſt aſſociations with the idea of death are of the diſguſtful and alarming kind; and they are collected from all quarters, from the ſenſible pains of every ſort, from the imperfection, weakneſs, loathſomeneſs, corruption, and diſorder, where diſeaſe, old age, death animal or vegetable, prevail, in oppoſition to the beauty, order, and luſtre of life, youth, and health; from the ſhame and contempt attending the firſt in many inſtances; whereas the laſt are honourable, as being ſources of power and happineſs, the reward of virtue, &c. and from the ſympathetic paſſions in general. And it is neceſſary, that the heedleſſneſs and inexperience of infancy and youth ſhould be guarded by ſuch terrors, and their headſtrong appetites and paſſions curbed, that they may not be hurried into danger and deſtruction before they are aware. It is proper alſo, that they ſhould form ſome expectations with reſpect to, and ſet ſome value upon, their future life in this world, that ſo they may be better qualified to act their parts in it, and make the quicker progreſs to perfection during their paſſage through it.

When children begin to have a ſenſe of religion and duty formed in them, theſe do ſtill farther heighten and increaſe the fear of death for the moſt part. For though there are rewards on the one hand, as well as puniſhments on the other; yet fear has got the ſtart from the natural cauſes of it before-mentioned: and as pain is in general greater than pleaſure, as was ſhewn above, from its conſiſting in ſtronger vibrations; ſo fear is in general more vivid than hope, eſpecially in children.

Moreover, the ſenſual and ſelfiſh appetites are the original of all the reſt; yet theſe are ſinful, and inconſiſtent with our own and other's happineſs; they muſt therefore be reſtrained, and at laſt eradicated. But parents and governors, are, in this caſe, more apt to have recourſe to fear, than to hope (in general, I ſuppoſe with reaſon, becauſe hope is too feeble to withſtand the violence of the natural appetites and paſſions). And it is to be added to all, that adults, by diſcovering, in general, much more of fear and ſorrow in the apprehenſions or proſpect of death, than of hope and comfort, from the continuance of the cauſes juſt mentioned, propagate and increaſe the fear ſtill farther in one another, and in children, infecting all around them, as is uſual in other caſes of the like kind. And by this means it comes to paſs, that the fear of death does in ſome circumſtances, particularly where the nervous ſyſtem is, through a bodily diſorder, reduced to an aptneſs to receive uneaſy and diſguſtful vibrations, only or chiefly, being in a ſtate of irritability approaching to pain, grow to a moſt enormous ſize, collecting and uniting every diſagreeable idea and impreſſion under the aſſociations belonging to death; ſo that ſuch perſons live in perpetual anxiety and ſlavery to the fear of death. And where there is the conſciouſneſs of paſt guilt, or the want of an upright intention for the future, it rages with ſtill greater fierceneſs, till theſe be removed entirely, or in part, by repentance and amendment.

It is farther to be obſerved, that the fear of death is much increaſed by the exquiſiteneſs of the puniſhments threatened in a future ſtate, and by the variety of the emblems, repreſentations, analogies, and evidences, of natural and revealed religion, whereby all the terrors of all other things are transferred upon theſe puniſhments; alſo by that peculiar circumſtance of the eternity of them, which ſeems to have been a general tradition previous to the appearance of chriſtianity, amongſt both *Jews* and *Pagans*, and which has been the doctrine and opinion of the chriſtian world ever ſince, ſome very few perſons excepted. The conſideration of any thing that is infinite, ſpace, time, power, knowledge, goodneſs, perfection, &c. quite overpowers the faculties of the ſoul with wonder and aſtoniſhment: and when the peculiar feeling and concern belonging to *ſelf* are applied here, and excited by the word *infinite*, by meditation, reading, &c. we muſt, and we ought to be alarmed to the full extent of our capacities. And the ſame concluſion follows, though we ſhould ſuppoſe the puniſhments of a future ſtate not to be abſolutely and metaphyſically infinite. *For their great* exquiſiteneſs, and long duration, which are moſt clearly and plainly declared in the ſcriptures, make them practically ſo.

This is a brief ſketch of the origin and progreſs of the fears attending the conſideration of death, and a future ſtate. We now come to inquire, how the hopes are generated.

Firſt, then, We are to obſerve, that repentance, amendment, the conſciouſneſs of paſt virtue, and of good intentions for the future, give a title to the hopes and rewards of a future ſtate; and that though while there are perpetual alternations of oppoſite conſciouſneſſes, *i. e.* recollections and judgments on our own actions, the fear may prevail in general, both from the additional weight of the natural fear, and from the previous poſſeſſion which the religious fear has obtained; yet by degrees the agreeable conſciouſneſs muſt prevail in thoſe who are ſincere (and ſometimes it is to be feared a deluſive one of the ſame kind in others), moderate the religious fear by little and little, and, in great meaſure, overcome the natural one; for which the way has been prepared from the ſuperior ſtrength of the religious fear, which has already obſcured it in ſerious perſons. And thus by degrees hope will begin to take place, as the general ſtate of the mind, and the conſideration of death, and a future ſtate, become, for the moſt part, matter of joy and comfort.

Secondly, The deliverance from the fear of death adds greatly to this joy, in the ſame way as the removal of other pains is made the ſource of pleaſure. And the returns of the fear of death at certain intervals, according to the ſtate of our bodies or minds, and the moral qualities of our actions, will, if they be not too frequent, keep up this ſource of pleaſure in the hope of futurity.

Thirdly, When the ſlaviſh fear of God is thus removed by faith and hope, all the pleaſing ſympathetic affections, ſuch as love, gratitude, confidence, begin to exert themſelves with reſpect to God, in a manner analogous, but a degree far ſuperior to that in which they are exerted towards men. And it is eaſy to ſee how theſe, and ſuch like cauſes concurring, may, in many caſes, quite overcome the natural and religious fears of death and pain, and even make them acceptable.

Cor. From hence we may paſs to the fervours of devotion; theſe being chiefly the hopes, and pleaſing affections, juſt ſpoken of, coaleſcing together ſo intimately by repeated aſſociations, as that the ſeparate parts there mentioned cannot be diſtinguiſhed from each other in the compound. And as theſe fervours are themſelves often eſteemed a ſign of holineſs, and conſequently a foundation of farther hope, they perpetuate and increaſe themſelves for a certain time, *i. e.* till the new convert finds the reiterated appearance of the ſame ideas give leſs and leſs emotion and pleaſure, juſt as in the other pleaſures, ſenſible and intellectual; looks upon this as a mark of ſpiritual

deſertion;

deſertion; finds numberleſs, unexpected, unthought-of, ſins and imperfections, not yet ſubdued; falls into bodily diſorders, from unſeaſonable ſeverities, or ſpiritual intemperance, &c. and thus becomes dejected, ſcrupulous, and fearful.

By degrees the fears taken from death, and a future ſtate, are confined to the mere apprehenſion of tranſgreſſion, without any regard had to thoſe, and even where they, when conſidered and expected, raiſe no fears.

However, all theſe things mortify pride, and the refined ſelf-intereſt; lead, or even compel, men to reſign all to God; and ſo advance them to a more pure, diſintereſted, and permanent love of God, and of their neighbour, than they could have arrived at (all other things remaining the ſame), had they not undergone theſe anxieties; and therefore are to be eſteemed the kind corrections of an infinitely merciful Father.

SECT. IV.

OF THE PLEASURES AND PAINS OF SYMPATHY.

PROP. XCVII.

To examine how far the Pleaſures and Pains of Sympathy are agreeable to the foregoing Theory.

The ſympathetic affections may be diſtinguiſhed into four claſſes, viz.

Firſt, Thoſe by which we rejoice at the happineſs of others.

Secondly, Thoſe by which we grieve for their miſery.

Thirdly, Thoſe by which we rejoice at their miſery.

And, Fourthly, Thoſe by which we grieve for their happineſs.

Of the firſt kind are ſociality, good-will, generoſity and gratitude. Of the ſecond, compaſſion and mercy. Of the third, moroſeneſs, anger, revenge, jealouſy, cruelty, and malice. And of the fourth, emulation and envy.

It is eaſy to be conceived, that aſſociation ſhould produce affections of all theſe four kinds, ſince in the intercourſes of life the pleaſures and pains of one are, in various ways, intermixed with, and dependent upon, thoſe of others, ſo as to have cluſters of their miniatures excited, in all the poſſible ways in which the happineſs or miſery of one can be combined with the happineſs or miſery of another *i. e.* in the four above-mentioned. I will now enter upon the detail of the riſe and progreſs of each of them.

OF THE AFFECTIONS BY WHICH WE REJOICE AT THE HAPPINESS OF OTHERS.

The firſt of theſe is ſociality, or the pleaſure which we take in the mere company and converſation of others, particularly of our friends and acquaintance, and which is attended with mutual affability, complaiſance, and candour. Now moſt of the pleaſures which children receive are conferred upon them by others, their parents, attendants, or play-fellows. And the number of the pleaſures which they receive in this way, is far greater than that of the pains brought upon them by others. Indeed the hurts, and bodily injuries, which they meet with, are chiefly from themſelves; and the denials of gratifications are either very few in number, or, if they be more frequent, give little uneaſineſs. It appears therefore, that, according to the doctrine of aſſociation, children ought to be pleaſed, in general, with the ſight and company of all their acquaintance. And the ſame things, with ſome alterations hold in reſpect of adults, through the whole courſe, and general tenour of human life.

Beſides the pleaſures for which we are indebted to others, there are many which we enjoy in common with others, and in their company and converſation, and which therefore both enhance and are enhanced by, the gaiety and happineſs that appear in the countenances, geſtures, words, and actions of the whole company. Of this kind are the pleaſures of feaſting, ſports and paſtimes, rural ſcenes, polite arts, mirth, raillery, and ridicule, public ſhews, public rejoicings, &c. And in general it may be obſerved, that the cauſes of joy and grief are common to great numbers, affecting mankind according to the ſeveral diviſions and ſubdiviſions thereof into nations, ranks, offices, ages, ſexes, families, &c.

And by all theſe things it comes to paſs, that the face of an old acquaintance brings to view, as it were, the indiſtinct mixed recollection, the remaining veſtiges of all the good and evil which we have felt, while his idea has been preſent with us.

The ſame obſervation may be made upon places; and particularly upon thoſe where a man has ſpent his infancy and youth.

To all this it is to be added, that the rules of prudence, good manners, and religion, by reſtraining all ruſticity, moroſeneſs, and inſolence, and obliging us to actions of a contrary nature, even though we have not the proper internal feelings, do by degrees contribute to beget theſe in us, *i. e.* to beget ſociality and complaiſance; juſt in the ſame manner, as a perſon in a paſſion becomes much more inflamed from his own angry expreſſions, geſtures, and actions.

Good-will, or benevolence, when underſtood in a limited ſenſe, may be termed that pleaſing affection which engages us to promote the welfare of others to the beſt of our power. If it carry us ſo far as to forego great pleaſures, or endure great pains it is called generoſity. But good-will and benevolence, in a general ſenſe, are put for all the ſympathetic affections of the firſt and ſecond claſs, viz. thoſe by which we either rejoice in, and promote, the happineſs of others, or grieve for, and endeavour to remove, their miſery; as ill-will and malevolence, underſtood in a general ſenſe alſo, are put for the contrary affections, viz. thoſe of the third and fourth claſs.

Benevolence, in the limited ſenſe, is nearly connected with ſociality, and has the ſame ſources. It has alſo a high degree of honour and eſteem annexed to it, procures us many advantages, and returns of kindneſs, both from the perſon obliged and others; and is moſt cloſely connected with the hope of reward in a future ſtate, and with the pleaſures of religion, and of ſelf-approbation, or the moral ſenſe. And the ſame things hold with reſpect to generoſity in a much higher degree. It is eaſy therefore to ſee, how ſuch aſſociations may be formed in us, as to engage us to forego great pleaſure, or endure great pain, for the ſake of others; how theſe aſſociations may be attended with ſo great a degree of pleaſure as to over-rule the poſitive pain endured, or the negative one from the foregoing of a pleaſure; and yet how there may be no direct, explicit expectation of reward, either from God or man, by natural conſequence, or expreſs appointment, not even of the concomitant pleaſure which engages the agent to undertake the benevolent or generous action. And this I take to be a proof from the doctrine of aſſociation, that there is, and muſt be, ſuch a thing as pure diſintereſted benevolence; alſo a juſt account of the origin and nature of it.

Gratitude includes benevolence, and therefore has the ſame ſources with ſome additional ones; theſe laſt are the explicit or implicit recollection of the benefits and pleaſures received, the hope of future ones, the approbation of the moral character of the benefactor, and the pleaſures from the honour and eſteem attending gratitude, much enhanced by the peculiar baſeneſs and ſhamefulneſs of ingratitude.

OF THE AFFECTIONS BY WHICH WE GRIEVE FOR THE MISERY OF OTHERS.

Compaſſion is the uneaſineſs which a man feels at the miſery of another. Now this in children ſeems to be grounded upon ſuch aſſociations as theſe that follow: the very appearance and idea of any kind of miſery which they have experienced, or of any ſigns of diſtreſs which they underſtand, raiſe up in their nervous ſyſtems a ſtate of miſery from mere memory,

mory, on account of the ſtrength of their imaginations; and becauſe the connection between the adjuncts of pain, and the actual infliction of it, has not yet been ſufficiently broken by experience, as in adults. —When ſeveral children are educated together, the pains, the denials of pleaſures, and the ſorrows, which affect one, generally extend to all in ſome degree, often in an equal one.—When their parents, attendants, &c. are ſick or afflicted, it is uſual to raiſe in their minds the naſcent ideas of pains and miſeries, by ſuch words and ſigns as are ſuited to their capacities; they alſo find themſelves laid under many reſtraints on this account.—And when theſe and ſuch like circumſtances have raiſed the deſires and endeavours to remove the cauſes of theſe their own internal uneaſy feelings, or, which is the ſame thing, of theſe miſeries of others (in all which they are much influenced, as in other like caſes, by the great diſpoſition to imitate, before ſpoken of); and a variety of internal feelings and deſires of this kind are ſo blended and aſſociated together, as that no part can be diſtinguiſhed ſeparately from the reſt; the child may properly be ſaid to have compaſſion.

The ſame ſources of compaſſion remain, though with ſome alterations, during our whole progreſs through life; and an attentive perſon may plainly diſcern the conſtituent parts of his compaſſion, while they are yet the mere internal, and, as one may ſay, ſelfiſh feelings above-mentioned; and before they have put on the nature of compaſſion by coaleſcence with the reſt.

Agreeably to this method of reaſoning, it may be obſerved, that perſons whoſe nerves are eaſily irritable, and thoſe who have experienced great trials and afflictions, are, in general, more diſpoſed to compaſſion than others; and that we are moſt apt to pity in thoſe diſeaſes and calamities, which we either have felt already, or apprehend ourſelves in danger of feeling hereafter.

But adults have alſo many other ſources of compaſſion, beſides thoſe already mentioned, and which differ according to their educations and ſituations in life. When love, natural affection, and friendſhip, have taught men to take a peculiar delight in certain objects, in mutual endearments, and familiar intercourſes, thoſe miſeries affecting the beloved objects, which either totally deſtroy, or greatly interrupt, theſe intercourſes, muſt give an exquiſite uneaſineſs; and this uneaſineſs, by mixing itſelf with the other parts of our compaſſionate affections, will greatly increaſe the ſum total in reſpect of theſe beloved objects.—A compaſſionate temper being great matter of praiſe to thoſe who are endued with it, and the actions which flow from it being a duty incumbent on all, men are led to practiſe theſe actions, and to inculcate upon themſelves the motives of compaſſion, by attending to diſtreſs actually preſent, or deſcribed in hiſtory, real or fictitious.—The peculiar love and eſteem which we bear to morally good characters, make us more ſenſibly touched with their miſeries; which is farther augmented by our indignation, and want of compaſſion for morally ill characters, ſuffering the juſt puniſhment of their crimes. In like manner, the ſimplicity, the ignorance, the helpleſsneſs, and the many innocent diverting follies of young children, and of ſome brutes, lead men to pity them in a peculiar manner.

Mercy has the ſame general nature and ſources as compaſſion, and ſeems to differ from it only in this, that the object of it has forfeited his title to happineſs, or the removal of miſery, by ſome demerit, particularly againſt ourſelves. Here, therefore, reſentment for an injury done to ourſelves, or what is called a juſt indignation againſt vice in general, interferes, and checks the otherwiſe natural courſe of our compaſſion, ſo as, in the unmerciful, entirely to put a ſtop to it. But, in the merciful, the ſources of compaſſion prevail over thoſe of reſentment and indignation; whence it appears, that the compaſſion required in acts of mercy, is greater than that in common acts of mere compaſſion: agreeably to which, it is obſervable, that mercy is held in higher eſteem, than mere compaſſion.

OF THE AFFECTIONS BY WHICH WE REJOICE AT THE MISERY OF OTHERS.

We come now to the affections of the third claſs, viz. moroſeneſs, anger, revenge, jealouſy, cruelty, and malice. Now moroſeneſs, peeviſhneſs, ſeverity, &c. are moſt apt to ariſe in thoſe perſons who have ſome real or imaginary ſuperiority over others, from their rank, years, office, accompliſhments, &c. which either magnifies the failures of duty in inferiors with reſpect to them, or engages them to be very attentive to theſe.—Bodily infirmities, and frequent diſappointments, by making the common intercourſes of life inſipid, and enhancing ſmall injuries; delicacy and effeminacy, by increaſing the ſenſibility both of body and mind, with reſpect to pain and uneaſineſs; luxury, by begetting unnatural cravings, which claſh not only with the like cravings of others, but alſo with the common courſe and conveniencies of human life; and, in ſhort, all kinds of ſelfiſhneſs; have the ſame ill effect upon the temper.—The ſevere ſcrutiny which earneſt penitents make into their own lives, during their novitiate, and the rigid cenſures which they paſs upon their own actions, are often found, in proud and paſſionate tempers, to raiſe ſuch indignation againſt vice, as breaks out into an undue ſeverity of language and behaviour, in reſpect of others; and this eſpecially, if they ſeem to themſelves to have overcome all great vices, and are not yet arrived at a juſt ſenſe of the many latent corruptions ſtill remaining in them. And this is much increaſed by all opinions which repreſent the Deity as implicable towards a part of mankind, and this part as reprobate towards him. By all which we may ſee, that every thing which makes diſagreeable impreſſions upon our minds at the ſame time that our fellow-creatures, or their ideas, are preſent with us; and eſpecially if theſe be linked together in the way of cauſe and effect, or by any ſuch relation; will, in fact, beget in us moroſeneſs and peeviſhneſs. This follows from the doctrine of aſſociation; and is alſo an evident fact. It is likewiſe a ſtrong argument for cheerfulneſs, and the pleaſures of innocent moderate mirth.

Anger and cruelty are the oppoſites to mercy and compaſſion; the firſt, as a ſudden ſtart of paſſion, by which men wiſh and endeavour harm to others, and rejoice in it when done; which is revenge: the latter as a more ſettled habit of mind, diſpoſing men to take a delight in inflicting miſery and puniſhment, and in ſatiating their thirſt after theſe, by beholding the tortures and anguiſh of the ſufferers.

Anger and revenge may be analyſed as follows. The appearance, idea, approach, actual attack, &c. of any thing from which a child has received harm, muſt raiſe in his mind, by the law of aſſociation, a miniature trace of that harm. The ſame harm often ariſes from different cauſes, and different harms from the ſame cauſe: theſe harms and cauſes have an affinity with each other: and thus they are variouſly mixed and connected together; ſo as that a general confuſed idea of harm, with the uneaſy ſtate of the nervous ſyſtem, and the conſequent activity of the parts, are raiſed up in young children upon certain appearances and circumſtances. By degrees the denial of gratifications, and many intellectual aggregates,

gates, with all the ſigns and tokens of theſe, raiſe up a like uneaſineſs, in the manner before explained. And thus it happens, that when any harm has been received, any gratification denied, or other mental uneaſineſs occaſioned, a long train of aſſociated remainders of painful impreſſions enhance the diſpleaſure, and continue it much beyond its natural period. This is the naſcent ſtate of the paſſion of anger, in which it is nearly allied to fear, being the continuance of the ſame internal feelings, quickened, on one hand, by the actual, painful, or uneaſy impreſſion, but moderated on the other by the abſence of the apprehenſion of future danger.

By degrees the child learns, from obſervation and imitation, to uſe various muſcular exertions, words, geſtures, &c. in order to ward off or remove the cauſes of uneaſineſs or pain, ſo as to ſtrike, talk loud, threaten, &c. and ſo goes on multiplying perpetually, by farther and farther aſſociations, both the occaſions of anger, and the expreſſions of it; and particularly aſſociates a deſire of hurting another with the apprehenſion, or the actual receiving, of harm from that other.

As men grow up to adult age, and diſtinguiſh living creatures from things inanimate, rational and moral agents from irrational ones, they learn to refer effects to their ultimate cauſes; and to conſider all the intermediate ones as being themſelves effects, depending on the ultimate cauſe. And thus their reſentment paſſes from the inanimate inſtrument to the living agent; and more eſpecially, if the living agent be a rational and moral one. For, Firſt, Living rational agents are alone capable of being reſtrained by threatenings and puniſhments from committing the injurious action. All our expreſſions of anger muſt therefore be directed againſt them.—Secondly, Inanimate things are incapable of feeling the harms which anger wiſhes: the deſire of revenge muſt therefore be entirely confined to animals. And theſe two things have great influence on each other. Our threatening harm merely from a motive of ſecurity, leads us to wiſh it really; wiſhing it leads us to threaten and inflict it, where it can afford no ſecurity or advantage to us.—Thirdly, As we improve in obſervation and experience, and in the faculty of analyſing the actions of animals, we perceive that brutes and children, and even adults in certain circumſtances, have little or no ſhare in the actions referred to them; but are themſelves under the influence of other cauſes, which therefore are to be deemed the ultimate ones. Hence, our reſentment againſt them muſt be much abated in theſe caſes, and transferred to the ultimate living cauſe, uſually called the free agent, if ſo be that we are able to diſcover him.—Laſtly, When the moral ideas of juſt and *unjuſt*, right and wrong, merit and *demerit*, *have* been acquired, and applied to the actions and circumſtances of human life in the manner to be hereafter deſcribed, the internal feelings of this claſs, *i. e.* the complacency and approbation attending the firſt, the diſguſt, diſapprobation, and even abhorrence, attending the laſt, have great influence in moderating or increaſing our reſentment. The aſſociations of the firſt kind are at utter variance with thoſe ſuggeſted by the ſenſe of pain; of the laſt, coincide with and ſtrengthen it. And as the rectitude of the moral ſenſe is the higheſt matter of encomium, men are aſhamed not to be thought to ſubmit all their private feelings to its ſuperior authority, and acquieſce in its determinations. And thus, by degrees, all anger and reſentment in theory, all that even ill men will attempt to juſtify, is confined to injury, to ſufferings which are not deſerved, or which are inflicted by a perſon who has no right to do it. And this at laſt makes it ſo in fact, to a great degree, amongſt thoſe who are much influenced by their own moral ſenſe, or by that of others. Yet ſtill, as a confirmation of the foregoing doctrine, it is eaſy to obſerve, that many perſons are apt to be offended even with ſtocks and ſtones, with brutes, with hurts merely accidental and undeſigned, and with puniſhments acknowledged to be juſtly inflicted; and this in various degrees, according to the various natural and acquired diſpoſitions of their minds.

Cruelty and malice are conſidered, not as paſſions of the mind, but as habits, as the deliberate wiſhing of miſery to others, delighting in the view and actual infliction of it, and this without the conſideration of injury received or intended. However, it will eaſily appear, that they are the genuine and neceſſary offſpring of anger indulged and gratified. They are moſt apt to ariſe in proud, ſelfiſh, and timorous perſons, thoſe who conceive highly of their own merits, and of the conſequent injuſtice of all offences againſt them; and who have an exquiſite feeling and apprehenſion, in reſpect of private gratifications and uneaſineſſes. The low and unhappy condition of thoſe around a man gives a dignity to his own; and the infliction of puniſhment, or mere ſuffering, ſtrikes a terror, and ſo affords ſecurity and authority. Add to theſe, the pleaſures ariſing from gratifying the will before explained, and perhaps ſome from mere curioſity, and the rouſing an obdurate callous mind to a ſtate of ſenſibility. Thus we may perceive how nearly one ill paſſion is related to another; and that it is poſſible for men to arrive at laſt at ſome degree of pure diſintereſted cruelty and malice.

The jealouſy againſt a rival in the affections of a beloved perſon of the other ſex; alſo that peculiar reſentment againſt this beloved perſon, when ſuſpected to be unfaithful, which goes by the ſame name; are eaſily deducible from their ſources, in the manner ſo often repeated. And it is owing to the extraordinary magnitude of the paſſions and pleaſures between the ſexes, and the ſingular contempt and ridicule thrown upon the perſon deſpiſed and deceived (the laſt of which ſprings from the firſt), that theſe two ſorts of jealouſy riſe to ſuch a height. This is more peculiarly remarkable in the ſouthern climates, where the paſſions between the ſexes are more violent than amongſt us. The nature and origin of jealouſies and ſuſpicions of other kinds, with the affections attending them, may eaſily be underſtood from what has been already advanced.

OF THE AFFECTIONS BY WHICH WE GRIEVE FOR THE HAPPINESS OF OTHERS.

Emulation and envy make the fourth claſs of the ſympathetic affections. Theſe are founded in the deſire of pleaſures, honours, riches, power, &c. and the conſequent engroſſing what others deſire, loſing what they obtain, in a compariſon of our own acquiſitions with thoſe of others, &c. by which the happineſs of others is connected with our miſery; ſo that at laſt we become uneaſy at their happineſs, even where there is no ſuch connection, *i. e.* emulate and envy where our own intereſt is no ways concerned.

Having now ſeen, in ſome meaſure, the nature and origin of the principal ſympathetic affections, pleaſing and tormenting, moral and immoral, let us conſider the ſeveral objects upon which theſe various and contrary affections are exerted.

I begin with the moſt intimate of all the relations of life; that of huſband and wife. Where this union is cemented by the ſeveral pleaſures of ſenſation and imagination before-mentioned, alſo by thoſe of the moral and religious kinds hereafter to be deſcribed, love, generoſity, gratitude, compaſſion, and all the affections of the firſt and ſecond claſs, prevail in the higheſt degree poſſible, to the excluſion of all thoſe of the third and fourth claſs; ſo that the marriage-ſtate, in theſe caſes, affords the moſt perfect earneſt and pattern, of which our imperfect condition here admits, of the future happineſs of the good in another world. And it is remarkable, that this ſtate is in ſcripture made the emblem of future happineſs, and of the union of Chriſt with the church.

Where the ties of affection are weaker, and particularly where there is a great deficiency in the moral or religious diſpoſitions of either or both the parties, the paſſions of the third claſs intermix themſelves with thoſe of the firſt and ſecond; and, in many caſes, the oppoſite affections prevail in great degrees alternately, and even at ſhort and frequent intervals. And indeed each kind often becomes more violent from ſucceeding its oppoſite.

In very immoral and wicked perſons the paſſions of the third claſs prevail almoſt entirely, and that eſpecially where the peculiar affection, called love by young perſons, and which ſprings from the pleaſures of ſenſation, imagination, and ambition, in the manner above explained, was originally weak.

The affection of parents towards children ſeems to begin from the pain which the mother feels in bringing them into the world, and the ſympathetic fears and cares of the father in conſequence thereof, and in ſome degree from children's being ſuppoſed to belong to their parents in a very peculiar ſenſe, and being parts of their own bodies. It is increaſed, eſpecially in mothers, by all the ſigns of life, ſenſe, and diſtreſs, which the helpleſs tender infant ſhews; many religious and moral conſiderations, with the language in which theſe are expreſſed, adding alſo great force thereto. The giving ſuck in the mother, with all the fears and cares in both parents, increaſes it ſtill farther; and as the child advances in age and underſtanding, diverts by his little follies, pleaſes by his natural beauty, draws on the encomiums of others, ſurprizes by his agility or wit, &c. the affections continue to riſe. When the time comes for the cultivation of the moral and religious powers of the mind, theſe either increaſe the affection by their proper appearance and growth, or check it by being deficient, and by giving occaſion to cenſures and corrections. Yet even theſe laſt, when juſtly proportioned, and followed by mental improvement, add greatly to the warmth of affection by raiſing compaſſion. And thus the remainders of former affections, and the acceſſions of new ones, ſeem to make a ſum total, which grows perpetually greater in tender and religious parents.

The little affection commonly ſhewn to baſtards agrees very well with the foregoing hiſtory of parental affection.

The affection towards grand-children is, in general, the ſame as that towards children, differing chiefly in this, that it is more fond and tender, and leſs mixed with ſeverity, and the neceſſary corrections. This may be, perhaps, becauſe the appearance of the helpleſs infant, after ſo long an interval, raiſes up all the old traces of parental affection with new vigour, from their not having been exerted for ſome years, and by recalling many of the moſt moving ſcenes of the foregoing life; ſo that theſe old traces, increaſed by the addition of new ſimiliar ones, make together a greater ſum total than before: or, perhaps, becauſe old perſons have more experience, of pain, ſorrow, and infirmity; and ſo are more diſpoſed to compaſſion, in the ſame manner as they are more apt to weep; and becauſe they excuſe themſelves from the uneaſy taſk of cenſuring and reproving.

The affections of children towards their parents are founded in the many pleaſures which they receive from them, or in their company. Theſe affections are afterwards increaſed by their improvement in morality and religion, and by the ſeveral common cauſes of good-will, gratitude, compaſſion, &c. prevailing here with peculiar force. It ſeems, however, that the ſources of this affection are fewer and weaker than the ſources of that towards children; and it is obſerved in fact, that the affection of children is in general weaker than that of parents. For which alſo an evident final cauſe may be aſſigned. It is to be added farther, that the many engagements and diſtractions, which lay hold of the opening faculties of young perſons, upon their entrance into life, have a principal ſhare in this effect.

Friendſhip, with the bitter enmities that ſometimes ſucceed the breaches of it, and the emulation and envy that are apt to ariſe in friends, from the equality and ſimilarity of their circumſtances, may be eaſily underſtood from what has been delivered already.

In like manner we may explain the affections between perſons of the ſame family, brothers, couſins, &c. of the ſame age, ſex, diſtrict, education, temper, profeſſion, &c.

By all theſe artificial ties our good-will and compaſſion are perpetually extended more and more, growing alſo perpetually weaker and weaker, in proportion to their diffuſion. Yet ſtill the common bleſſings and calamities, which fall upon whole nations and communities; the general reſemblance of the circumſtances of all mankind to each other, in their paſſage through life; their common relation to God as their creator, governor, and father; their common concern in a future life, and in the religion of Chriſt, &c. are capable of raiſing ſtrong ſympathetic affections towards all mankind, and the ſeveral larger diviſions of it, in perſons of religious diſpoſitions, who duly attend to theſe things. In like manner the opinions of ſavageneſs, barbarity, and cruelty, which ignorant and unexperienced perſons are apt to entertain, concerning ſome diſtant nations, raiſe up in their minds ſome degrees of general diſlike, averſion, and hatred.

SECT.

SECT. V.

OF THE PLEASURES AND PAINS OF THEOPATHY.

PROP. XCVIII.

To examine how far the Pleaſures and Pains of Theopathy are agreeable to the foregoing Theory.

UNDER this claſs I comprehend all thoſe pleaſures and pains, which the contemplation of God, and his attributes, and of our relation to him raiſes up in the minds of different perſons, or in that of the ſame perſon at different times. And in order to ſpeak with more preciſion concerning this claſs of affections, and to deduce them more readily from the theory of theſe papers, it will be proper firſt to inquire into the idea of God, as it is found in fact amongſt men, particularly amongſt *Jews* and *Chriſtians*, *i. e.* to inquire what aſſociations may be obſerved in fact to be heaped upon, and concur in this word, and the equivalent and related terms and phraſes.

Firſt, then, It is probable, that, ſince many actions and attributes belonging to men are, and indeed muſt be, in common language, applied to God, children, in their firſt attempts to decypher the word God, will ſuppoſe it to ſtand for a man, whom they have never ſeen, and of whom conſequently they form a compound fictitious idea, conſiſting of parts before generated by men, whom they have ſeen.

Secondly, when they hear or read, that God reſides in heaven (*i. e.* according to their conceptions, in the ſky, amongſt the ſtars), that he made all things, that he ſees, hears, and knows all things, can do all things, &c. with the many particular modes of expreſſion that are comprehended under theſe general ones, vivid ideas, which ſurprize and agitate the mind (lying upon the confines of pain), are raiſed in it; and if they be ſo far advanced in underſtanding, as to be affected with apparent inconſiſtencies and impoſſibilities in their ideas, they muſt feel great perplexity of imagination, when they endeavour to conceive and form definite ideas agreeable to the language of this kind, which they hear and read. Now this perplexity will add to the vividneſs of the ideas, and all together will transfer upon the word God, and its equivalents, ſuch ſecondary ideas, as may be referred to the heads of magnificence, aſtoniſhment, and reverence.

Thirdly, When children hear that God cannot be ſeen, having no viſible ſhape, no parts; but that he is a ſpiritual infinite being; this adds much to their perplexity and aſtoniſhment, and by degrees deſtroys the aſſociation of the fictitious viſible idea beforementioned with the word God. However, it is probable, that ſome viſible ideas, ſuch as thoſe of the heavens, a fictitious throne placed there, a multitude of angels, &c. ſtill continue to be excited by the word God, and its equivalents, when dwelt upon in the mind.

Fourthly, When the child hears, that God is the rewarder of good actions, and the puniſher of evil ones, and that the moſt exquiſite future happineſs or miſery (deſcribed by a great variety of particulars and emblems) are prepared by him for the good and bad reſpectively; he feels ſtrong hopes and fears riſe alternately in his mind, according to the judgment which he paſſes upon his own actions, founded partly upon the previous judgment of others, partly upon an imperfect moral ſenſe begun to be generated in him.

And laying all theſe things together it will appear, that amongſt *Jews* and *Chriſtians*, children begin probably with a definite viſible idea of God; but that by degrees this is quite obliterated, without any thing of a ſtable preciſe nature ſucceeding in its room; and that, by farther degrees, a great variety of ſtrong ſecondary ideas, *i. e.* mental affections (attended indeed by viſible ideas, to which proper words are affixed, as of angels, the general judgment, &c.) recur in their turns, when they think upon God, *i. e.* when this word, or any of its equivalents, or any equivalent phraſe or ſymbol, ſtrike the mind ſtrongly, ſo that it dwells upon them for a ſufficient time, and is affected by them in a ſufficient degree.

Amongſt heathen nations, where idolatry and polytheiſm prevail, the caſe is different; but this difference may eaſily be underſtood by applying the foregoing method of reaſoning to the circumſtances of the heathen world.

I will now inquire more particularly into the nature and origin of the affections exerted towards God. They may be ranked under two general heads, love and fear; agreeably to the general diviſion of the ſympathetic affections into benevolence and malevolence. However, the analogy here is not a complete one, as will be ſeen preſently.

To the love of God may be referred gratitude, confidence and reſignation; alſo enthuſiaſm, which may be conſidered as a degeneration of it. To the fear, reverence (which is a mixture of love and fear); alſo ſuperſtition and atheiſm, which are degenerations of the fear of God.

OF THE LOVE OF GOD.

The love of God, with its aſſociates, gratitude, confidence and reſignation, is generated by the contemplation of his bounty and benignity to us, and to all his creatures, as theſe appear from the view of the natural world, the declarations of the ſcriptures, or a man's own obſervation and experience in reſpect of the events of life. It is ſupported, and much increaſed, by the conſciouſneſs of upright intentions, and ſincere endeavours, with the conſequent hope of a future reward, and by prayer, vocal and mental, public and private, inaſmuch as this gives a reality and force to all the ſecondary ideas before ſpoken of. Frequent converſation with devout perſons, and frequent reading of devout books, have great efficacy alſo, from the infectiouſneſs of our tempers and diſpoſitions, and from the perpetual recurrency of the proper words, and of their ſecondary ideas; firſt in a faint ſtate, afterwards in a ſtronger and ſtronger perpetually. The contemplation of the reſt of the divine attributes, his omnipotence, omniſcience, eternity, ubiquity, &c. have alſo a tendency to ſupport and augment the love of God, when this is ſo far advanced, as to be ſuperior to the fear; till that time theſe wonderful attributes enhance the fear ſo much, as to check the riſe and growth of the love for a time. Even the fear itſelf contributes to the generation and augmentation of the love in an eminent degree, and in a manner greatly analogous to the production of other pleaſures from pains. And indeed it ſeems, that, notwithſtanding the variety of ways above-mentioned, in which the love of God is generated, and the conſequent variety of the intellectual aggregates, and ſecondary ideas, there muſt be ſo great a reſemblance amongſt them, that they cannot but languiſh by frequent recurrency, till ſuch time as ideas of an oppoſite nature, by intervening at certain ſeaſons, give them new life.

The love of God is, according to this theory, evidently deduced in part from intereſted motives directly, viz. from the hopes of a future reward; and thoſe motives to it, or ſources of it, in which direct explicit ſelf-intereſt does not appear, may yet be analyſed up to it ultimately. However, after all the ſeveral ſources of the love of God have coaleſced together, this affection becomes as diſintereſted as any other; as the pleaſure we take in any natural or artificial beauty, in the eſteem of others, or even in ſenſual gratifications.

It appears alſo, that this pure diſintereſted love of God may, by the concurrence of a ſufficient number of ſufficiently ſtrong aſſociations, ariſe to ſuch a height, as to prevail over any of the other deſires intereſted or diſintereſted; for all, except the ſenſual ones, are of a factitious nature, as well as the love of God; and the ſenſual ones are, in our progreſs through life, overpowered by them all in their reſpective turns.

Enthuſiaſm may be defined a miſtaken perſuaſion in any perſon, that he is a peculiar favourite with God; and that he receives ſupernatural marks thereof. The vividneſs of the ideas of this claſs eaſily generates this falſe perſuaſion in perſons of ſtrong fancies, little experience in divine things, and narrow underſtandings (and eſpecially where the moral ſenſe, and the ſcrupuloſity attending its growth and improvement, are but imperfectly formed), by giving a reality and certainty to all the reveries of a man's own mind, and cementing the aſſociations in a preternatural manner. It may alſo be eaſily contracted by contagion, as daily experience ſhews; and indeed more eaſily than moſt other diſpoſitions from the glaring language uſed by enthuſiaſts, and from the great flattery and ſupport, which enthuſiaſm affords to pride and ſelf-conceit.

OF THE FEAR OF GOD.

The fear of God ariſes from a view of the evils of life, from the threatenings of the ſcriptures, from the ſenſe of guilt, from the infinity of all God's attributes, from prayer, meditation, reading, and converſation upon theſe and ſuch like ſubjects, in a manner analogous to the love of God. When confined within certain limits, and eſpecially when tempered with love, ſo as to become awe, veneration and reverence, it remains in a natural ſtate, *i. e.* ſuits our other circumſtances; and, as before obſerved, has a conſiderable ſhare in generating the love of God. When exceſſive, or not duly regarded, it degenerates either into ſuperſtition or atheiſm.

Superſtition may be defined a miſtaken opinion concerning the ſeverity and puniſhments of God, magnifying theſe in reſpect of ourſelves or others. It may ariſe from a ſenſe of guilt, from bodily indiſpoſition, from erroneous reaſoning, &c. That which ariſes from the firſt cauſe has a tendency to remove itſelf by regulating the perſon's behaviour, and conſequently leſſening his ſenſe of guilt. The other kinds often increaſe for a time, come to their height at laſt, and then decline again. They do alſo, in ſome caſes, increaſe without limits during life. All kinds of ſuperſtition have been productive of great abſurdities in divine worſhip, both amongſt *Pagans*, and amongſt *Jews* and *Chriſtians*; and they have all a great tendency to ſour the mind, to check natural benevolence and compaſſion, and to generate a bitter perſecuting ſpirit. All which is much augmented where ſuperſtition and enthuſiaſm paſs alternately into each other at intervals; which is no uncommon caſe.

Under atheiſm I here comprehend not only the ſpeculative kind, but the practical, or that neglect of God, where the perſon thinks of him ſeldom, and with reluctance, and pays little or no regard to him in his actions, though he does not deny him in words. Both kinds ſeem in chriſtian countries, where reaſonable ſatisfaction in religious matters is eaſy to be had by all well-diſpoſed minds, and groſs ignorance uncommon except in ill-diſpoſed ones, to proceed from an explicit or implicit ſenſe of guilt, and a conſequent fear of God, ſufficient to generate an averſion to the thoughts of him, and to the methods by which the love might be generated, and yet too feeble to reſtrain from guilt; ſo that they may properly be conſidered as degenerations of the fear of God. What has been delivered already in theſe papers, concerning the *connection* of fear, averſion, and the *other uneaſy* paſſions, with each other, and alſo of the tendency of all pain to prevent the recurrency of the circumſtances, by which it is introduced, may afford ſome light here.

It appears upon the whole, that the theopathetic affections are, in ſome things, analogous to the ſympathetic ones, as well as different in others; and that this difference ariſes chiefly from the infinity and abſolute perfection of the divine nature.

Affections of an intermediate kind are generated in reſpect of good and evil beings of an inviſible nature, and of an order ſuperior to us (ſuch as angels and devils); whoſe origin and growth will eaſily be underſtood from what is here delivered.

SECT. VI.

OF THE PLEASURES AND PAINS OF THE MORAL SENSE.

PROP. XCIX.

To examine how far the Pleaſures and Pains of the moral Senſe are agreeable to the foregoing Theory.

THERE are certain tempers of mind, with the actions flowing from them, as of piety, humility, reſignation, gratitude, &c. towards God; of benevolence, charity, generoſity, compaſſion, humility, gratitude, &c. towards men; of temperance, patience, contentment, &c. in reſpect of a perſon's own private enjoyments or ſufferings; which when he believes himſelf to be poſſeſſed of, and reflects upon, a pleaſing conſciouſneſs and ſelf-approbation riſe up in his mind, excluſively of any direct explicit conſideration of advantage likely to accrue to himſelf, from his poſſeſſion of theſe good qualities. In like manner the view of them in others raiſes up a diſintereſted love and eſteem for thoſe others. And the oppoſite qualities of impiety, profaneneſs, uncharitableneſs, reſentment, cruelty, envy, ingratitude, intemperance, lewdneſs, ſelfiſhneſs, &c. are attended with the condemnation both of ourſelves and others. This is, in general, the ſtate of the caſe; but there are many particular differences, according to the particular education, temper, profeſſion, ſex, &c. of each perſon.

Or, which is the ſame thing, the ſecondary ideas belonging to virtue and vice, duty and ſin, innocence and guilt, merit and demerit, right and wrong, moral good and moral evil, juſt and unjuſt, fit and unfit, obligation and prohibition, &c. in one man, bear a great reſemblance to thoſe belonging to the ſame words in another, or to the correſponding words, if they have different languages; and yet do not exactly coincide, but differ more or leſs, according to the difference in education, temper, &c.

Now both this general reſemblance, and theſe particular differences, in our ideas, and conſequent approbation or diſapprobation, ſeem to admit of an analyſis and explanation from the following particulars.

Firſt, Children are, for the moſt part, inſtructed in the difference and oppoſition between *virtue and vice, duty and ſin, &c.* and have ſome general deſcriptions of the virtues and vices inculcated upon them. They are told, that the firſt are good, pleaſant, beautiful, noble, fit, worthy of praiſe and reward, &c. the laſt odious, painful, ſhameful, worthy of puniſhment, &c. ſo that the pleaſing and diſpleaſing aſſociations, previouſly annexed to theſe words in their minds, are, by means of that confidence which they place in their ſuperiors, transferred upon the virtues and vices reſpectively. And the mutual intercourſes of life have the ſame effect in a leſs degree, with reſpect to adults, and thoſe children who receive little or no inſtruction from their parents or ſuperiors. Virtue is in general approved, and ſet off by all the encomiums, and honourable appellations, that any other thing admits of, and vice loaded with cenſures and reproaches of all kinds, in all good converſation and books. And this happens oftener than the contrary, even in bad ones; ſo that as far as men are influenced in their judgments by thoſe of others, the balance is, upon the whole, on the ſide of virtue.

Secondly, There are many immediate good conſequences, which attend upon virtue, as many ill ones do upon vice, and that during our whole progreſs through life. Senſuality and intemperance ſubject men to diſeaſes and pain, to ſhame, deformity, filthineſs, terrors, and anxieties; whereas temperance is attended with eaſe of body, freedom of ſpirits, the capacity of being pleaſed with the objects of pleaſure, the good opinion of others, the perfection of the ſenſes, and of the faculties bodily and mental, long life, plenty, &c. Anger, malice, envy, bring upon us the returns of anger, malice, envy, from others, with injuries, reproaches, fears, and perpetual diſquietude; and in like manner good-will, generoſity, compaſſion, are rewarded with returns of the ſame, with the pleaſures of ſociality and friendſhip, with good offices, and with the higheſt encomiums. And when a perſon becomes properly qualified by the previous love of his neighbour to love God, to hope and truſt in him, and to worſhip him in any meaſure as he ought to do, this affords the ſincereſt joy and comfort; as, on the contrary, the neglect of God, or practical atheiſm, the murmuring againſt the courſe of Providence, ſceptical unſettledneſs, and fool-hardy impiety, are evidently attended with great anxieties, gloomineſs, and diſtraction, as long as there are any traces of morality or religion left upon men's minds. Now theſe pleaſures and pains, by often recurring in various combinations, and by being variouſly transferred upon each other, from the great affinity between the ſeveral virtues and their rewards, with each other; alſo between the ſeveral vices, and their puniſhments, with each other; will at laſt beget in us a general, mixed, pleaſing idea and conſciouſneſs, when we reflect upon our own virtuous affections or actions; a ſenſe of guilt, and an anxiety, when we reflect on the contrary; and alſo raiſe in us the love and eſteem of virtue, and the hatred of vice in others.

Thirdly, The many benefits which we receive immediately from, or which have ſome evident, though diſtant, connection with the piety, benevolence, and temperance of others; alſo the contrary miſchiefs from their vices; lead us firſt to the love and hatred of the perſons themſelves by aſſociation, as explained under the head of ſympathy, and then by farther aſſociations to the love and hatred of the virtues and vices, conſidered abſtractedly, and without any regard to our own intereſt; and that whether we view them in ourſelves or others. As our love and eſteem for virtue in others is much increaſed by the pleaſing conſciouſneſs, which our own practice of it affords to ourſelves, ſo the pleaſure of this conſciouſneſs is much increaſed by our love of virtue in others.

Fourthly, The great ſuitableneſs of all the virtues to each other, and to the beauty, order, and perfection of the world, animate and inanimate, impreſſes a very lovely character upon virtue; and the contrary ſelf-contradiction, deformity, and miſchievous tendency of vice, render it odious, and matter of abhorrence to all perſons that reflect upon theſe things; and beget a language of this kind, which is borrowed, in great meaſure, from the pleaſures and pains of imagination, and applied with a peculiar force and fitneſs to this ſubject from its great importance.

Fifthly, The hopes and fears which ariſe from the conſideration of a future ſtate, are themſelves pleaſures and pains of a high nature. When therefore a ſufficient foundation has been laid by a practical belief of religion, natural and revealed, by the frequent view of, and meditation upon, death, by the loſs of departed friends, by bodily pains, by worldly diſappointments and afflictions, for forming ſtrong aſſociations of the pleaſures of theſe hopes with duty, and the pains of theſe fears with ſin, the reiterated impreſſions of thoſe aſſociations will at laſt make duty itſelf a pleaſure, and convert ſin into a pain, giving a luſtre and deformity reſpectively to all their appellations; and that without any expreſs recollection of the hopes and fears of another world, juſt as in other caſes of aſſociation.

Sixthly, All meditations upon God, who is the inexhauſtible fountain, and infinite abyſs, of all perfection, both natural and moral; alſo all the kinds of prayer, *i. e.* all the ways of expreſſing our love, hope, truſt, reſignation, gratitude, reverence, fear, deſire, &c. towards him; transfer by aſſociation, all the perfection, greatneſs, and glorioufneſs of his natural attributes upon his moral ones, *i. e.* upon moral rectitude. We ſhall by this means learn to be merciful, holy, and perfect, becauſe God is ſo; and to love mercy, holineſs, and perfection, whereever we ſee them.

And thus we may perceive, that all the pleaſures and pains of ſenſation, imagination, ambition, ſelf-intereſt, ſympathy, and theopathy, as far as they are conſiſtent with one another, with the frame of our natures, and with the courſe of the world, beget in us a moral ſenſe, and lead us to the love and approbation of virtue, and to the fear, hatred, and abhorrence of vice. This moral ſenſe therefore carries its own authority with it, inaſmuch as it is the ſum total of all the reſt, and the ultimate reſult from them; and employs the force and authority of the whole nature of man againſt any particular part of it, that rebels againſt the determinations and commands of the conſcience or moral judgment.

It appears alſo, that the moral ſenſe carries us perpetually to the pure love of God, as our higheſt and ultimate perfection, our end, centre, and only reſting-place, to which yet we can never attain.

When the moral ſenſe is advanced to conſiderable perfection, a perſon may be made to love and hate, merely becauſe he ought, *i. e.* the pleaſures of moral beauty and rectitude, and the pains of moral deformity and unfitneſs, may be transferred, and made to coaleſce almoſt inſtantaneouſly.

Scrupuloſity may be conſidered as a degeneration of the moral ſenſe, reſembling that by which the fear of God paſſes into ſuperſtition; for it ariſes like this, from a conſciouſneſs of guilt, explicit or implicit, from bodily indiſpoſition, and from an erroneous method of reaſoning. It has alſo a moſt intimate connection with ſuperſtition (juſt as moral rectitude has with the true love and fear of God); and, like ſuperſtition, it is, in many caſes, obſerved to work its own cure by rectifying what is amiſs; and ſo by degrees removing both the explicit and implicit conſciouſneſs of guilt. It ſeems alſo, that in this imperfect ſtate men ſeldom arrive at any great degree of correctneſs in their actions without ſome previous ſcrupuloſity, by which they may be led to eſtimate the nature and conſequences of affections and actions with care, impartiality and exactneſs.

The moral ſenſe or judgment here ſpoken of, is ſometimes conſidered as an inſtinct, ſometimes as determinations of the mind, grounded on the eternal reaſons and relations of things. Thoſe who maintain either of theſe opinions may, perhaps, explain them ſo as to be conſiſtent with the foregoing analyſis of the moral ſenſe from aſſociation. But if by inſtinct be meant a diſpoſition communicated to the brain, and in conſequence of this, to the mind, or to the mind alone, ſo as to be quite independent of aſſociation; and by a moral inſtinct, ſuch a diſpoſition producing in us moral judgments concerning affections and actions; it will be neceſſary, in order to ſupport the opinion of a moral inſtinct, to produce inſtances, where moral judgments ariſe in us independently of prior aſſociations determining thereto.

In like manner, if by founding the morality of actions, and our judgment concerning this morality, on the eternal reaſons and relations of things be meant, that the reaſons drawn from the relations of things, by which the morality or immorality of certain actions is commonly proved, and which, with the relations, are called eternal, from their appearing the ſame, or nearly the ſame, to the mind at all times, would determine the mind to form the correſponding moral judgment independently of prior aſſociations, this ought alſo to be proved by the allegation of proper inſtances. To me it appears, that the inſtances are, as far as we can judge of them, of an oppoſite nature, and favour the deduction of all our moral judgments, approbations, and diſapprobations, from aſſociation alone. However, ſome aſſociations are formed ſo early, repeated ſo often, riveted ſo ſtrong, and have ſo cloſe a connection with the common nature of man, and the events of life which happen to all, as in a popular way of ſpeaking, to claim the appellation of original and natural diſpoſitions; and to appear like inſtincts, when compared with diſpoſitions evidently factitious; alſo like axioms, and intuitive propoſitions, eternally true according to the uſual phraſe, when compared with moral reaſonings of a compound kind. But I have endeavoured to ſhew in theſe papers, that all reaſoning, as well as affection, is the mere reſult of aſſociation.

CONCLUSION;

CONTAINING SOME REMARKS ON THE

MECHANISM OF THE HUMAN MIND.

Besides the conſequences flowing from the doctrine of aſſociation, which are delivered in the Corollaries to the fourteenth Propoſition, there is another, which is thought by many to have a pernicious tendency in reſpect of morality and religion; and which therefore it will be proper that I ſhould conſider particularly.

The conſequence I mean is that of the mechaniſm or neceſſity of human actions, in oppoſition to what is generally termed free-will. Here then I will,

Firſt, State my notion of the mechaniſm or neceſſity of human actions.

Secondly, Give ſuch reaſons as induce me to embrace the opinion of the mechaniſm of human actions.

Thirdly, Conſider the objections and difficulties attending this opinion.

And, laſtly, Allege ſome preſumptions in favour of it from its conſequences.

By the mechaniſm of human actions I mean, that each action reſults from the previous circumſtances of body and mind, in the ſame manner, and with the ſame certainty, as other effects do from their mechanical cauſes; ſo that a perſon cannot do indifferently either of the actions *A*, and its contrary *a*, while the previous circumſtances are the ſame; but is under an abſolute neceſſity of doing one of them, and that only. Agreeably to this I ſuppoſe, that by free-will is meant a power of doing either the action, *A*, or its contrary *a*; while the previous circumſtances remain the ſame.

If by free-will be meant a power of beginning motion, this will come to the ſame thing; ſince, according to the opinion of mechaniſm, as here explained, man has no ſuch power; but every action, or bodily motion, ariſes from previous circumſtances, or bodily motions, already exiſting in the brain, *i. e.* from vibrations, which are either the immediate effect of impreſſions then made, or the remote compound effect of former impreſſions, or both.

But if by free-will be meant any thing different from theſe two definitions of it, it may not perhaps be inconſiſtent with the mechaniſm of the mind here laid down. Thus, if free-will be defined the power of doing what a perſon deſires or wills to do, of deliberating, ſuſpending, chooſing, &c. or of reſiſting the motives of ſenſuality, ambition, reſentment, &c. free-will, under certain limitations, is not only conſiſtent with the doctrine of mechaniſm, but even flows from it; ſince it appears from the foregoing theory, that voluntary and ſemivoluntary powers of calling up ideas, of exciting and reſtraining affections, and of performing and ſuſpending actions ariſe from the mechaniſm of our natures. This may be called free-will in the popular and practical ſenſe, in contradiſtinction to that, which is oppoſed to mechaniſm, and which may be called free-will in the philoſophical ſenſe.

I proceed now to the arguments which favour the opinion of mechaniſm.

Firſt, then, It is evident to, and allowed by all, that the actions of mankind proceed, in many caſes, from motives, *i. e.* from the influence which the pleaſures and pains of ſenſation, imagination, ambition, ſelf-intereſt, ſympathy, theopathy, and the moral ſenſe, have over them. And theſe motives ſeem to act like all other cauſes. When the motive is ſtrong, the action is performed with vigour; when weak, feebly. When a contrary motive intervenes, it checks or over-rules, in proportion to its relative ſtrength, as far as one can judge. So that where the motives are the ſame, the actions cannot be different; where the motives are different, the actions cannot be the ſame. And it is matter of common obſervation, that this is the caſe in fact, in the principal actions of life, and ſuch where the motives are of a magnitude ſufficient to be evident. It is reaſonable therefore to interpret the obſcure caſes by the evident ones; and to infer, that there are in all inſtances motives of a proper kind and degree, which generate each action; though they are ſometimes not ſeen through their minuteneſs, or through the inattention or ignorance of the obſerver. Agreeably to which thoſe perſons, who ſtudy the cauſes and motives of human actions, may decypher them much more completely, *both in them*ſelves, and thoſe with whom they converſe, than others can.

Suppoſe now a perſon able to decypher all his own actions in this way, ſo as to ſhew that they correſponded in kind and degree to the motives ariſing from the ſeven claſſes of pleaſures and pains conſidered in this theory; alſo able to decypher the principal actions of others in the ſame way: this would be as good evidence, that motives were the mechanical cauſes of actions, as natural phænomena are for the mechanical operation of heat, diet, or medicines. Or if he could not proceed ſo far, but was able only to decypher moſt of his own actions, and many of the principal ones of others, ſtill the evidence would ſcarce be diminiſhed thereby, if the deficiency was no more than is reaſonably to be expected from our ignorance and inattention, in reſpect of ourſelves and others. Let the reader make the trial, eſpecially upon himſelf, ſince ſuch a ſelf-examination cannot but be profitable, and may perhaps be pleaſant; and that either according to the ſeven claſſes of pleaſures and pains here laid down, or any other diviſion, and judge as he thinks fit upon mature deliberation.

It may be of uſe in ſuch an inquiry into a man's ſelf, as I here propoſe, for him to conſider in a ſhort time after any material action is paſt, whether, if he was once more put into the ſame rigidly exact circumſtances, he could poſſibly do otherwiſe than as he did. Here the power of imagination will intervene, and be apt to deceive the inquirer, unleſs he be cautious. For in this review other motives, beſides thoſe which did actually influence him, will ſtart up; and that eſpecially if the action be ſuch as he wiſhes to have been performed with more vigour or leſs, or not to have been performed at all. But when theſe foreign motives are ſet aſide, and the imagination confined to thoſe which did in fact take place, it will appear impoſſible, as it ſeems to me, that the perſon ſhould have done otherwiſe than the very thing which he did.

Secondly, According to the theory here laid down, all human actions proceed from vibrations in the nerves of the muſcles, and theſe from others, which are either evidently of a mechanical nature, as in the automatic motions; or elſe have been ſhewn to be ſo in the account given of the voluntary motions.

And if the doctrine of vibrations be rejected, and ſenſation and muſcular motion be ſuppoſed to be performed by ſome other kind of motion in the nervous parts, ſtill it ſeems probable, that the ſame method of reaſoning might be applied to this other kind of motion.

Laſtly, To ſuppoſe, that the action *A*, or its contrary *a*, can equally follow previous circumſtances, that are exactly the ſame, appears to me the ſame thing, as affirming that one or both of them might ſtart up into being without any cauſe; which, if admitted, appears to me to deſtroy the foundation of all general abſtract reaſoning; and particularly of that whereby the exiſtence of the firſt cauſe is proved.

One of the principal objections to the opinion of mechaniſm is that deduced from the exiſtence of the moral ſenſe, whoſe hiſtory I have juſt given. But it appears from that hiſtory, that God has ſo formed the world, and perhaps (with reverence be it ſpoken) was obliged by his moral perfections ſo to form it, as that virtue muſt have amiable and pleaſing ideas affixed to it; vice, odious ones. The moral ſenſe is therefore generated neceſſarily and mechanically. And it remains to be inquired, whether the amiable and odious ideas above ſhewed to be neceſſarily affixed to virtue and vice reſpectively, though differently according to the different events, of each perſon's life, do not anſwer all the purpoſes of making us ultimately happy in the love of God, and of our neighbour; and whether they are not, *cæteris paribus*, the ſame entirely, or at leaſt in all material reſpects, in thoſe who believe mechaniſm, who believe free-will, and who have not entered into the diſcuſſion of the queſtion at all: or if there be a difference, whether the aſſociations ariſing from the opinion of neceſſity, do not tend more to accelerate us in our progreſs to the love of God, our only true happineſs. It appears to me, that the difference is in general very ſmall; alſo that this difference, whatever it be, is of ſuch a nature as to be a preſumption, in favour of the doctrine of neceſſity, all things being duly conſidered.

When a perſon firſt changes his opinion from free-will to mechaniſm, or more properly firſt ſees part of the mechaniſm of the mind, and believes the reſt from analogy, he is juſt as much affected by his wonted pleaſures and pains, hopes and fears, as before, by the moral and religious ones, as by others. And the being perſuaded, that certain things have a neceſſary influence to change his mind for the better or the worſe, *i. e.* ſo as to receive more ſenſible, ſympathetic, religious pleaſures, or otherwiſe, will force him ſtill more ſtrongly upon the right method, *i. e.* put him upon inquiring after and purſuing this method.

If it be objected, That the moral ſenſe ſuppoſes, that we refer actions to ourſelves and others, whereas the opinion of mechaniſm annihilates all thoſe aſſociations, by which we refer actions to ourſelves or others; I anſwer, that it does this juſt as the belief of the reality and infinite value of the things of another world annihilates all the regards to this world. Both have a tendency to theſe reſpective ends, which are indeed one and the ſame at the bottom; but both require time, in order to produce their full effects. When religion has made any one indifferent to this world, its pleaſures and pains, then the kingdom of God, or pure unmixed happineſs, comes in reſpect of him; ſo that he may then well refer all to God. However, a man may be thoroughly ſatisfied in a cool deliberate way, that honours, riches, &c. can afford no ſolid happineſs; and yet deſire them at certain times, eagerly, perhaps, from former aſſociations. But ſuch a thorough general conviction, applied previouſly to the particular inſtances, is a great help in time of temptation, and will gradually deſtroy the wrong aſſociations. In like manner, the opinion that God is the one only cauſe of all things, has a tendency to beget the moſt abſolute reſignation, and muſt be a great ſupport in grievous trials and ſufferings.

We may ſhew by a like method of reaſoning, that the affections of gratitude and reſentment, which are intimately connected with the moral ſenſe, remain notwithſtanding the doctrine of mechaniſm. For it appears from the account of reſentment above delivered, that this, and by conſequence gratitude, in their naſcent ſtate, are equally exerted towards all things, animate and inanimate, that are equally connected with pleaſure and pain. By degrees all ſucceeding circumſtances are left out, and our love and hatred confined to preceding ones, which we conſider as the only cauſes. We then leave out inanimate objects entirely, brutes and children in moſt circumſtances, and adults in ſome. All which is chiefly done, becauſe acknowledgments, rewards, threatenings, and puniſhments, with the other aſſociated circumſtances of gratitude and reſentment, can have no uſe but with reſpect to living intelligent beings. By farther degrees we learn ſuch a uſe of the words, cauſe, and effect, as to call nothing a cauſe, whoſe cauſe, or preceding circumſtance, we can ſee, denominating all ſuch things mere effects, all others cauſes. And thus, becauſe the ſecret ſprings of action in men are frequently concealed, both from the by-ſtander, and even from the agent himſelf, or not attended to, we conſider men in certain circumſtances as real cauſes; and intelligent beings, as the only ones that can be real cauſes; and thus confine our gratitude and reſentment to them: whence it ſeems to follow, that as ſoon as we diſcover created intelligent beings *not to be* real cauſes, we ſhould ceaſe to make them the objects either of gratitude or reſentment. But this is in great meaſure, ſpeculation; for it will appear to every attentive perſon, that benevolence, compaſſion, &c. are amiable, and the objects of gratitude, envy and malice the contrary, from whatever cauſes they proceed, *i. e.* he will find his mind ſo formed already by aſſociation, that he cannot withhold his gratitude or reſentment: and it has been my buſineſs in the foregoing analyſis of the affections, to point out the ſeveral methods by which this and ſuch like things are brought about. And, for the ſame reaſons, a perſon muſt aſcribe merit and demerit, which are alſo intimately connected with the moral ſenſe, to created intelligent beings, though he may have a full perſuaſion, that they are not real cauſes.

It does indeed appear, that this is owing to our preſent imperfect ſtate, in which we begin with the idolatry of the creature, with the worſhip of every aſſociated circumſtance; and that as we advance in perfection, the aſſociations relating to the one only, ultimate, infinite cauſe, muſt at laſt overpower all the reſt; that we ſhall pay no regards but to God alone; and that all reſentment, demerit, ſin and miſery, will be utterly annihilated and abſorbed by his infinite happineſs and perfections. For our aſſociations being in this, as in many other caſes, inconſiſtent with each other, our firſt groſs and tranſitory ones muſt yield to thoſe which ſucceed and remain.

While any degree of reſentment, or unpleaſing affection, is left, it may be ſhewn, that the ſame aſſociations which keep it up, will turn it upon the creatures, and particularly upon ourſelves. And, on the other hand, when the conſideration of the ultimate cauſe ſeems ready to turn it from ourſelves, it will alſo ſhew that it ought to be annihilated.

Theſe may be conſidered as general remarks, tending to remove the difficulties ariſing from the conſideration of the moral ſenſe. I will now ſtate the principal objections to the opinion of mechaniſm, in a direct, but ſhort way, adding ſuch hints as appear to me to afford a ſolution of them.

Firſt, then, It may be ſaid, that a man may prove his own free-will by internal feeling. This is true, if by free-will be meant the power of doing what a man wills or deſires; or of reſiſting the motives of ſenſuality, ambition, &c. *i. e.* free-will in the popular and practical ſenſe. Every perſon may eaſily recollect inſtances, where he has done theſe ſeveral things. But then theſe are entirely foreign to the preſent queſtion. To prove that a man has free-will in the ſenſe oppoſite to mechaniſm, he ought to feel, that he can do different things, while the motives remain preciſely the ſame: and here I apprehend the internal feelings are entirely againſt free-will, where the motives are of a ſufficient magnitude to be evident; where they are not, nothing can be proved.

Secondly, It may be ſaid, that unleſs a man have free-will, he is not an agent. I anſwer, that this is true, if agency be ſo defined as to include free-will. But if agency have its ſenſe determined, like other words, from the aſſociated appearances, the objection falls at once. A man may ſpeak, handle, love, fear, &c. entirely by mechaniſm.

Thirdly, It may be ſaid, that the denial of free-will in man is the denial of it in God alſo. But to this it may be anſwered, that one does not know how to put the queſtion in reſpect of God, ſuppoſing free-will to mean the power of doing different things, the previous circumſtances remaining the ſame, without groſs anthropomorphitiſm. It does not at all follow, however, becauſe man is ſubject to a neceſſity ordained by God, that God is ſubject to a prior neceſſity. On the contrary, according to the doctrine of mechaniſm, God is the cauſe of cauſes, the one only ſource of all power.

Fourthly, It may be ſaid, that men are perpetually impoſed upon, unleſs they have free-will, *ſince they* think they have. But here again free-will is put for the power of doing what a man wills or deſires, &c. for, in the ſenſe oppoſite to mechaniſm, few perſons have ever entered into the diſcuſſion of the point at all; and thoſe who do with ſufficient attention, cannot but determine againſt free-will, as it ſeems to me.

Fifthly, It may be ſaid, That the doctrine of mechaniſm deſtroys the notion of a particular Providence altering the courſe of nature ſo as to ſuit it to the actions of men. I anſwer, That laying down philoſophical free-will, ſuch an alteration in the courſe of nature may perhaps be neceſſary. But if man's actions, and the courſe of nature, be both fixed, they may be ſuited to each other in the beſt poſſible manner; which is all that can be required, in order to vindicate God's attributes, as well as all that man can deſire.

Sixthly, It may be ſaid, that all motives to good actions, and particularly to prayer, are taken away by denying free-will. I anſwer, that according to the mechanical ſyſtem, prayer and good actions are the means for obtaining happineſs; and that the belief of this is the ſtrongeſt of motives to impel men to prayer and good works.

Seventhly, It may be ſaid, that the denial of free-will deſtroys the diſtinction between virtue and vice. I anſwer, that this is according as theſe words are defined. If free-will be included in the definition of virtue, then there can be no virtue without free-will. But if virtue be defined obedience to the will of God, a courſe of action proceeding from the love of God, or from benevolence, &c. free-will is not at all neceſſary; ſince theſe affections and actions may be brought about mechanically.

A ſolution analogous to this may be given to the objection taken from the notions of merit and demerit. Let the words be defined, and they will either include free-will, or, not including *it*, will not require it; ſo that the propoſition, *merit implies free-will*, will either be identical, or falſe.

Eighthly, It may be ſaid, that the doctrine of mechaniſm makes God the author of ſin. I anſwer, that till we arrive at ſelf-annihilation, ſin always will, and ought to appear to ariſe from ourſelves; and that, when we are arrived thither, ſin and evil of every kind vaniſh. I anſwer alſo, that the doctrine of philoſophical free-will does not remove our difficulties and perplexities, in reſpect of the moral attributes of God, unleſs by transferring them upon the natural ones, *i. e.* by our ſuppoſing that ſome prior neceſſity compelled God to beſtow free-will on his creatures. It ſeems equally difficult, in every way, to account for the origin of evil, natural or moral, conſiſtently with the infinity of the power, knowledge, and goodneſs of God. If we ſuppoſe, that all tends to happineſs ultimately, this removes the difficulty ſo far as to produce acquieſcence in the will of God, and thankfulneſs to him; and that juſt as much upon the ſyſtem of mechaniſm as that of free-will. Moral evil has no difficulty in it, beſides what ariſes from the natural evil attending it.

Ninthly, It may be ſaid, that the exhortations of the ſcriptures preſuppoſe free-will. I anſwer, That they are to be conſidered as motives impelling the will, and contributing, as far as they are attended to, to rectify it. A parent who believes the doctrine of mechaniſm may, conſiſtently with it, or rather muſt neceſſarily, in conſequence of this belief, exhort his child. Therefore God, who is pleaſed to call himſelf our heavenly Father, may do the ſame. And if we embrace the opinion of univerſal reſtoration, then all the exhortations contained both in the word and works of God, will produce their genuine effect, and concur to work in us diſpoſitions fit to receive happineſs ultimately.

I come now to hint ſome conſequences of the doctrine of mechaniſm, which ſeem to me to be ſtrong preſumptions in its favour.

Firſt, then, It entirely removes the great difficulty of reconciling the preſcience of God with the free-will of man. For it takes away philoſophical free-will, and the practical is conſiſtent with God's preſcience.

Secondly, It has a tendency to beget the moſt profound humility and ſelf-annihilation; ſince, according to this, we are entirely deſtitute of all power and perfection in ourſelves, and are what we are entirely by the grace and goodneſs of God.

Thirdly, It has a tendency to abate all reſentment againſt men. Since all that they do againſt us is by the appointment of God, it is rebellion againſt him to be offended with them.

Fourthly, It greatly favours the doctrine of univerſal reſtoration. Since all that is done is by the appointment of God, It cannot but end well at laſt.

Fifthly, It has a tendency to make us labour more earneſtly with ourſelves and others, particularly children, from the greater certainty attending all endeavours that operate in a mechanical way.

Laſtly, There are many well-known paſſages of ſcripture, which cannot be reconciled to the doctrine of philoſophical free-will, without the greateſt harſhneſs of interpretation.

It may alſo be objected to the whole foregoing theory, as well as to the doctrine of vibrations in particular, that it is unfavourable to the immateriality of the ſoul; and, by conſequence, to its immortality. But to this I anſwer, that I am reduced to the neceſſity of making a *poſtulatum* at the entrance of my inquiries; which precludes all poſſibility of proving the materiality of the ſoul from this theory afterwards. Thus I ſuppoſe, or poſtulate, in my firſt propoſition, that ſenſations ariſe in the ſoul from motions excited in the medullary ſubſtance of the brain. I do indeed bring ſome arguments from phyſiology and pathology, to ſhew this to be a reaſonable *poſtulatum*, when underſtood in a general ſenſe; for it is all one to the purpoſe of the foregoing theory, whether the motions in the medullary ſubſtance be the phyſical cauſe of the ſenſations, according to the ſyſtem of the ſchools; or the occaſional cauſe, according to *Malbranche*; or only an adjunct, according to *Leibnitz*. However, this is not ſuppoſing matter to be endued with ſenſation, or any way explaining what the ſoul is; but only taking its exiſtence, and connection with the bodily organs in the moſt ſimple caſe, for granted, in order to make farther inquiries. Agreeably to which I immediately proceed to determine the ſpecies of the motion, and by determining it, to caſt light on ſome important and obſcure points relating to the connection between the body and the ſoul in complex caſes.

It does indeed follow from this theory, that matter, if it could be endued with the moſt ſimple kinds of ſenſation, might alſo arrive at all that intelligence of which the human mind is poſſeſſed: whence this theory muſt be allowed to overturn all the arguments which are uſually brought for the immateriality of the ſoul from the ſubtlety of the internal ſenſes, and of the rational faculty. But I no ways preſume to determine whether matter can be endued with ſenſation or no. This is a point foreign to the purpoſe of my inquiries. It is ſufficient for me, that there is a certain connection, of one kind or other, between the ſenſations of the ſoul, and the motions excited in the medullary ſubſtance of the brain; which is what all phyſicians and philoſophers allow.

I would not therefore be any way interpreted ſo as to oppoſe the immateriality of the ſoul. On the contrary, I ſee clearly, and acknowledge readily, that matter and motion, however ſubtly divided, or reaſoned upon, yield nothing more than matter and motion ſtill. But then neither would I affirm, that this conſideration affords a proof of the ſoul's immateriality. In like manner the unity of conſciouſneſs ſeems to me an inconcluſive argument. For conſciouſneſs is a mental perception; and if *perception* be a monad, then every inſeparable adjunct of it muſt be ſo too, *i. e.* vibrations, according to this theory, which is evidently falſe. Not to mention, that it is difficult to know what is meant by the unity of conſciouſneſs.

But it is moſt worthy of notice, that the immateriality of the ſoul has little or no connection with its immortality; and that we ought to depend upon him who firſt breathed into man the breath of the preſent life, for our reſurrection to a better. *All live unto him.* And if we depend upon any thing elſe beſides him, for any bleſſing, we may be ſaid ſo far to renounce our allegiance to him, and to idolize that upon which we depend.

END OF THE FIRST PART.

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